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ABSTRACT

This book is one of a series of 10 units of instruction for roofing apprenticeship classes in California. It covers the following 14 topics and provides tests for them: the nature of the roofing and waterproofing industry; the apprenticeship program; apprenticeship and the public schools; collective bargaining, wages, and benefits; safety in the industry; types, styles, and structural designs of roofs; hand tools and power tools; equipment; introduction to kettles; lighting and loading of kettles; kettle heating; kettle cleaning and maintenance; roof pumps; and tankers. Each topic section consists of objectives, information sheets, and study assignments. Materials are illustrated with black and white pictures and line drawings. A glossary of roofing and waterproofing terms is included. Ten-item multiple choice tests are provided for each topic. (KC)

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# Roofing

## Workbook and Tests

## Entering the Roofing and Waterproofing Industry

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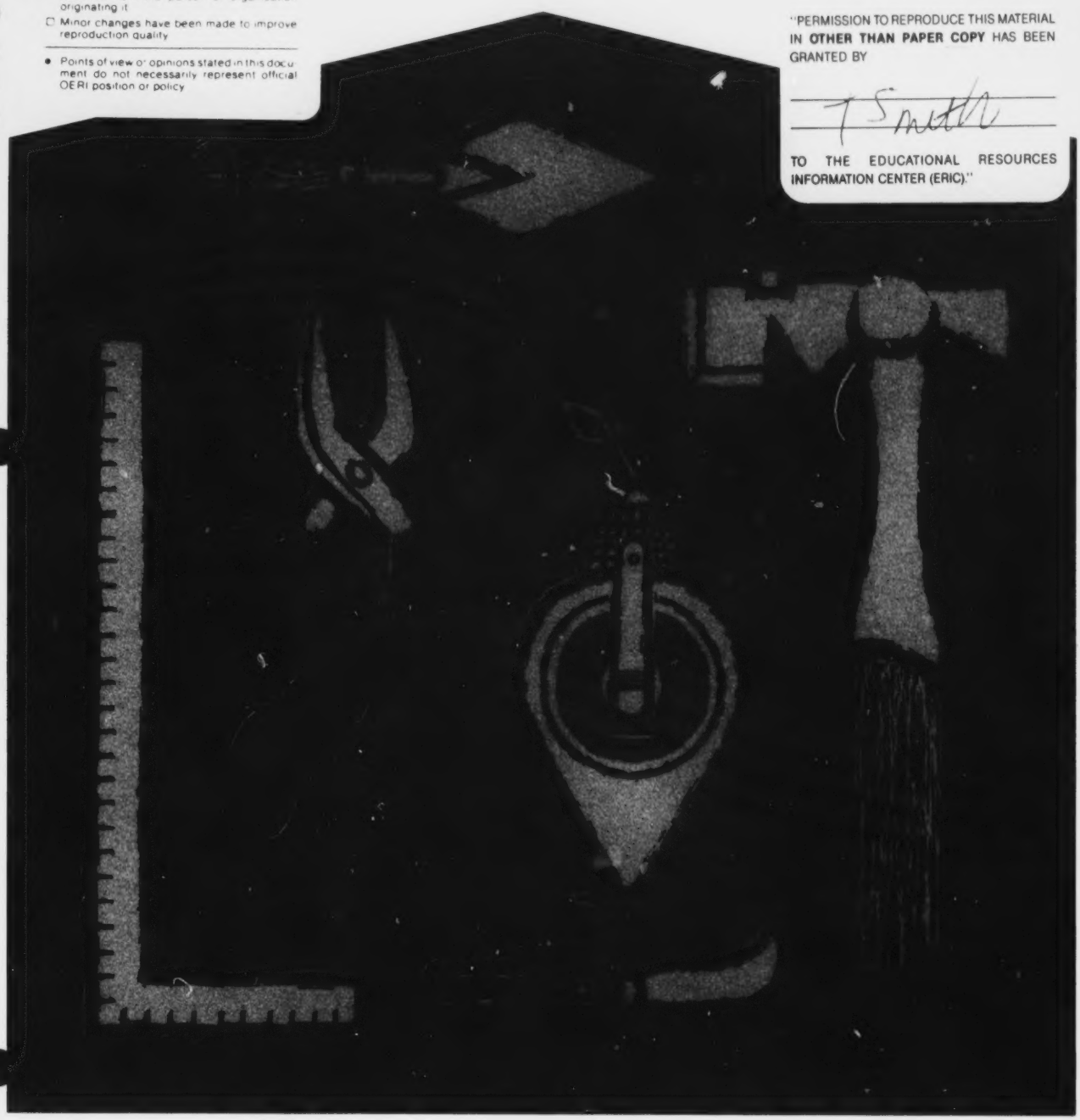

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A column labeled "Date Assigned" has been provided at the right-hand side of each page of the workbook section in the contents. Whenever your instructor assigns a topic, the date should be written in the appropriate blank. When you have completed the topic satisfactorily, your instructor should place his or her initials next to the assignment date. If this procedure has been followed, and you should transfer from one school to another, you will have an accurate record of the work you have completed. This procedure is intended to ensure that you complete each topic and to ensure that you do not have to duplicate work on topics already studied.

To provide other school records needed, be sure to fill in the blanks below, giving your name, home address, and telephone number. Then ask your instructor to fill in the official date of your enrollment in his or her class and to sign where indicated.

NAME _____

ADDRESS _____

_____ PHONE _____

DATE ENROLLED _____

INSTRUCTOR(S) _____

_____

# Roofing

## Workbook and Tests

## Entering the Roofing and Waterproofing Industry

*Prepared under the direction of the*
**Education Advisory Committee for the Roofing Industry**
**State Joint Roofing Industries Apprenticeship Committee**
*and the*
**Bureau of Publications, California Department of Education**

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Remittance or purchase order must accompany each order. Purchase orders without checks are accepted only from governmental agencies in California. Phone orders are not accepted.

The following titles, each containing workbook and tests in a single volume, are available in the roofing series:

| | |
|---|---|
| *Asphalt and Wood Shingling* (1982) (ISBN 0-8011-0601-x) | $5.25 |
| *Built-up Roofing* (1981) (ISBN 0-8011-0604-4) | 4.00 |
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| *Common Roofing and Waterproofing Materials and Equipment* (1982) (ISBN 0-8011-0610-9) | 5.25 |
| *Entering the Roofing and Waterproofing Industry* (1991) (ISBN 0-8011-0971-x) | 6.50 |
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A complete list of publications available from the Department of Education, including instructional materials for some 23 other trades, is available from the address given above.

Questions and comments about existing apprenticeship materials or the development of new materials should be directed to:

Theodore R. Smith or Bob Klingensmith
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California Department of Education
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Sacramento, CA 94244-2720
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# Foreword

IN THE California apprenticeship programs, experience gained on the job is supplemented by classroom work that is closely related to the job. This balanced system of training enables the apprentice to learn the "why" as well as the "how" of the trade. Both types of training are required for advancement in today's competitive industries.

The job-related courses for the skilled trades are highly specialized, and adequate training materials are for the most part not available commercially. To meet this need, the Department of Education, in cooperation with labor and management, develops the required training materials and makes them available to you at cost. This workbook is an example. It was written to provide you with the up-to-date information you must have to meet the growing technical demands of the roofing and waterproofing trade. Every effort has been made to make the workbook clear, comprehensive, and current.

I congratulate you on your choice of roofing and waterproofing as a career. The effort you put forth today to become a competent journey-level worker will bring you many rewards and satisfactions, and the benefits will extend also to your community. We need your skills and knowledge, and I wish you every success in your new venture.

Bill Honig

*State Superintendent of Public Instruction*

# Preface

THE Bureau of Publications in the California Department of Education provides for the development of instructional materials for apprentices under provisions of the California Apprentice Labor Standards Act. These materials are developed through the cooperative efforts of the Department of Education and employer-employee groups representing apprenticeable trades.

This 1991 edition of *Entering the Roofing and Waterproofing Industry* was planned and prepared under the direction of the Education Advisory Committee for the Roofing Industry, with the cooperation of the State Joint Roofing Industries Apprenticeship Committee. The members of this committee include representatives of the Roofing Contractors Association of California and representatives of local unions. Special thanks and appreciation are extended to Robert Culbertson, Sacramento, and M. Duane Mongerson, Oakland, for their efforts in bringing the original 1980 edition up to date.

This publication is one of a series of ten individually bound units of instruction for roofing apprenticeship classes. These books reflect the continuing cooperative effort of labor, management, local schools, and the Department of Education to provide the best instructional materials for California apprenticeship classes. They are dedicated to excellence in the training of roofing apprentices.

ROBERT LA LIBERTÉ
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*Editor in Chief*
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*Director, Information Systems*
*and Services Division*

TOPIC 1

# The Nature of the Roofing and Waterproofing Industry

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the materials used to construct roofs for early shelters.**
- **Identify the three basic needs that the roofing and waterproofing apprenticeship program is designed to meet.**
- **Discuss the scope of the roofing and waterproofing trade.**
- **Identify the responsibilities and functions of employee and employer organizations.**
- **Identify the reasons that a bright future is predicted for the roofing industry.**
- **Describe the challenges and requirements that an apprentice roofer must meet.**
- **Discuss the importance of the construction industry.**

THE craft of roofing originated several thousand years before the Christian era, and it has been practiced by every civilization in recorded history.

Early roofs were made from a variety of materials ranging from grass, weeds, and reeds to slate, tile, lead, and copper. Wood roofs became popular in the early 1700s, and coal-tar pitch and asphalt products were later developed to meet local conditions. Today, some of these products are being replaced by such "exotic" systems as elastomeric and sheet membrane.

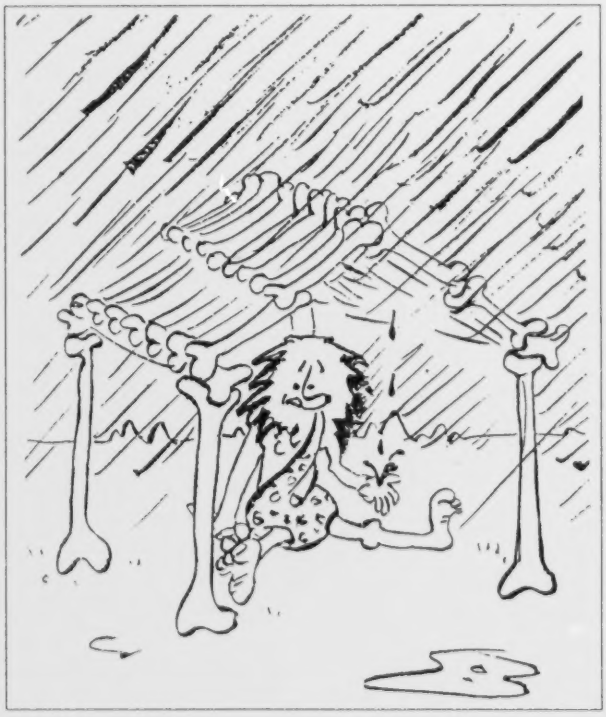
## The Background of Apprenticeship

Apprenticeship also had it origins in the remote past, and although it has undergone many changes over the years, it has withstood the test of time as a means of training new workers in the skilled crafts.

In the ancient beginnings of apprenticeship, the teaching of a skilled craft was the direct responsibility of a master, who taught the trade to his sons or other young men. The apprentice was virtually a slave, completely under the power of the master. The first historical phase of apprenticeship extended from biblical times to about the middle of the nineteenth century. The second phase began with the establishment of trade unions and their subsequent growth, when the responsibility of passing on trade skills gradually shifted to the respective crafts in the labor movement. Apprenticeship in the United States entered its third phase after passage of the Wagner Act (the National Labor Relations Act) in 1935; thereafter, as one result of collective bargaining, apprenticeship came to be a jointly sponsored program of labor and management.

## Roofing and Waterproofing Apprenticeship

Roofing and waterproofing apprenticeship is a system of on-the-job training combined with classes of



related instruction and study. This system has been designed to fill three basic needs: (1) to preserve the craft of roofing and waterproofing; (2) to supply skilled and technically qualified workers to industry; and (3) to provide a vocational education in roofing and waterproofing to young persons who demonstrate the aptitude, initiative, and ability to become journey-level roofers and waterproofers. Entrance into roofing and waterproofing apprenticeship has always been based on educational preparation, physical aptitudes, and employment opportunities. Apprentices are selected without regard to race, creed, color, sex, political opinions, national origin, or age.

### Benefits of the Apprenticeship Program

The three-year apprenticeship course in roofing and waterproofing in California provides the apprentice with valuable training, skills, and knowledge. It is very demanding, but it is also very satisfying and rewarding. Roofing apprentices earn good incomes during their training period, in contrast with college students, who usually must spend a considerable amount of money for their education and have little opportunity to earn while learning.

Successful completion of an apprenticeship brings the immediate reward of journey-level status in a skilled trade, and it also opens the door to many related career opportunities. For example, many apprenticeship-trained journey-level roofers go on to become supervisors or superintendents, and others become successful contractors. Besides these material advantages roofing and waterproofing apprenticeship provides the best foundation for enjoying a career in a craft that is very rewarding in its aesthetic values.

The achievement of excellence in the trade is worth the sacrifice, time, and study it demands during the learning years. The roofer who is soundly based in the theory of the trade as well as in the necessary mechanical skills will always be in demand. The inadequately trained "semiroofer," on the other hand, will not be able to meet the demands of changing technology and will all too often "walk the street." Industry has found no substitute for the first-rate craftsperson; several second-rate workers cannot replace him or her.

### Requirements for Apprentices

The roofing and waterproofing trade can be a strenuous, demanding, and very hazardous craft in which to work. Men and women who believe they are interested in pursuing a career in the industry should be aware of the variety of challenges and requirements they must face in completing an apprenticeship training program. For example, they must:

- Be physically able to perform the work of the trade.
- Be prepared to work at extreme heights and on sloping surfaces.
- Be prepared to lift heavy materials and equipment exceeding 100 pounds (45.4 kilograms).
- Be prepared to work in all types of weather.
- Be prepared to purchase necessary books and equipment.
- Be prepared to attend instructional classes.
- Be prepared to abide by the rules and regulations set by the joint apprenticeship committee (JAC) or joint apprenticeship and training committee (JATC).

### Importance of the Construction Industry

Construction is so interwoven into the fabric of our society that we are inclined to take it as much for granted as the air we breathe. In the whole range of our activities, every day of our lives, we use countless facilities made available by construction. The construction industry builds the homes we live in; the factories, mills, offices, and other places in which we work; the schools our children attend; our hospitals; and our places of worship. The vast complex of streets, highways, and freeways over which our commerce moves is made possible by construction; so are the wharves, docks, and piers that are essential to the maritime industry. Construction harnesses our rivers and thus provides flood control, water supplies, and electrical energy.

The list can be extended almost indefinitely. Almost every aspect of our complex social order is to some extent dependent on the construction industry.

### The Future of the Roofing and Waterproofing Industry

The employment of roofers and waterproofers is expected to increase faster than the average for all occupations through the 1990s. This projection is based on the need for new housing and other types of building to accommodate the rapidly expanding population in the age group of twenty-four through thirty-eight years. Another factor to be considered is the large number of housing units built in the 1960s, 1970s, and 1980s.

Over the next two decades, many of these structures will need to be reroofed because on the average a roof lasts from ten to 20 years.

New materials, products, and techniques of production have profoundly changed the industry and increased the demands made on workers in all the skilled trades. This is especially true for roofers and waterproofers. The roofing and waterproofing apprenticeship program is constantly being evaluated and updated to reflect new developments in the trade.

The apprentice roofer will find that there is much to learn. The intensely competitive construction industry eliminates the incompetent or unbusinesslike employer; but it even more brutally rejects the ignorant, dull, lazy, or unmotivated worker. The industry cannot waste time, effort, and money on apprentices who cannot or will not apply themselves to the difficult task of learning a skilled trade and earning a completion certificate.

Employee and employer organizations have played important roles in the roofing and waterproofing industry since the early 1900s. In 1945, for example, the United Slate, Tile, and Composition Roofers, Damp, and Waterproofer Workers Association (now the United Union of Roofers, Waterproofers, and Allied Workers) and the United Roofing Contractors Association (now the National Roofing Contractors Association) began to establish trade training for apprentices in accordance with the recommendations of the Federal Committee on Apprenticeship. In 1956 they formed the National Joint Apprenticeship and Training Committee for the Roofing Industry, which sets national standards for the industry and thereby helps to ensure the availability of versatile, thoroughly trained workers who are capable of producing economical, long-lasting, and perfectly executed work. Today, the United Union of Roofers, Waterproofers, and Allied Workers and the National Roofing Contractors Association continue to support strongly the apprenticeship concept.

## Study Assignments

1. **Read all reference materials supplied by the local joint apprenticeship committee or the state joint apprenticeship and training committee.**
2. **Review the constitution and by-laws of the United Union of Roofers, Waterproofers, and Allied Workers.**

TOPIC 2

# The Apprenticeship Program

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the federal and state legislation affecting apprenticeship programs.**
- **Identify the primary functions of the Bureau of Apprenticeship and Training and the Division of Apprenticeship Standards.**
- **Identify the basic criteria used in the selection of apprentices.**
- **Describe the duties and responsibilities of the local joint apprenticeship and training committee.**
- **Discuss the responsibilities of the apprentice, the employer, and the union.**

## Legislation for Apprenticeship

LEGISLATION has been enacted at both the federal and state levels to promote and develop apprenticeship. The basic federal act relating to apprenticeship is the Fitzgerald Act. California's basic apprenticeship law is the Shelley-Maloney Apprentice Labor Standards Act.

### The Fitzgerald Act

The Fitzgerald Act, passed by Congress in 1937, authorized the U.S. Secretary of Labor to promote labor standards for apprentices, to foster the welfare of apprentices, and to bring employers and labor together to enter into agreements establishing apprenticeship programs. By virtue of this authority, the Secretary of Labor established a national advisory committee on apprenticeship and an agency that is now known as the Bureau of Apprenticeship and Training (BAT). The principal functions of BAT are to promote effective apprenticeship and training programs and to provide technical assistance to industry in setting up such programs. In performing these functions, BAT works closely with state apprenticeship agencies, trade and industrial educational institutions, and representatives of management and labor.

### The Shelley-Maloney Act

Passage of the Shelley-Maloney Apprentice Labor Standards Act in 1939 provided the basis for an organized system of apprenticeship training in California. The intent of this law was to establish standards for minimum wages, maximum hours, and working conditions for apprentices and in general to promote apprenticeship and the welfare of the apprentice and industry.

An apprentice is defined in the Shelley-Maloney Act as a person at least sixteen years old (eighteen years for a roofer as required by the Fair Labor Standards Act) who has entered into a written apprenticeship agreement with an employer or his or her agent. The agreement must provide for reasonably continuous employment and for participation in an approved program of training in trade-related and supplemental subjects.

## Administration of Apprenticeship in California

Under the provisions of the Shelley-Maloney Act, the California Apprenticeship Council (CAC) was established as a policymaking body, and the Director of the Department of Industrial Relations was named as the Administrator of Apprenticeship. The Division of Apprenticeship Standards (DAS) in the Department of Industrial Relations was empowered to carry out the Department's responsibilities in regard to apprenticeship.

### The California Apprenticeship Council

In accordance with the provisions of the Shelley-Maloney Act and its amendments, the Governor appoints an Apprenticeship Council composed of the following: six representatives each of industry and labor; two representatives of the general public; the Director of the Department of Industrial Relations; the Chancellor of the California Community Colleges or his or her designee;

and a representative of the Career–Vocational Education Division in the California Department of Education. The California Apprenticeship Council promotes and develops apprenticeship throughout the state and establishes standards for minimum wages, maximum hours, and working conditions for apprentices.

#### The Division of Apprenticeship Standards

The Division of Apprenticeship Standards is the administrative arm of the California Apprenticeship Council. Its basic functions are to promote apprenticeship; assist employers and employees in the development of apprenticeship standards; assist employers, employees, schools, and other governmental and community agencies in coordinating their activities in apprenticeship; and advise and assist apprenticeship committees in the operation and improvement of their training programs.

### The Joint Apprenticeship Committee

Apprenticeship arrangements at the local level are handled by local joint apprenticeship committees (JACs) or joint apprenticeship and training committees (JATCs), which are made up of an equal number of employer and employee representatives. Normally, apprentices are registered with the local JAC or JATC that has jurisdiction in the geographical area where they receive their on-the-job training and in the school district where they receive their related classroom instruction.

#### Apprenticeship Standards

The local joint apprenticeship committee operates its apprenticeship program under authority granted to it by the participating employer and employee organizations. This authority is established in a written agreement called an apprenticeship labor standards agreement, usually referred to simply as the "apprenticeship standards" for the program. The apprenticeship standards are adopted by the joint apprenticeship committee and approved by the Division of Apprenticeship Standards.

The apprenticeship standards contain rules and regulations for conducting the apprenticeship program, and they spell out the duties and responsibilities of the local joint apprenticeship committee or joint apprenticeship and training committee.

#### Duties and Responsibilities of the Local JAC

In conformance with the apprenticeship standards, the JAC or JATC selects and indentures apprentices, supervises on-the-job training, and assists and advises the school in the related instructional program. The committee also keeps records of each apprentice's progress, enforces discipline as required (this may include cancelling an apprenticeship for just cause), approves transfers, and recommends issuance of certificates of completion when apprentices have earned them. Also, approval of the JAC or JATC is required before an apprentice can be advanced to the next higher rate of pay, and this depends on the apprentice's work record and progress in related instruction.

The members of the local JAC or JATC serve on a voluntary basis, their only compensation being the satisfaction of contributing to the three basic purposes of apprenticeship: (1) preservation of the craft of roofing and waterproofing; (2) supplying industry's need for skilled workers; and (3) providing qualified persons an opportunity to receive a well-rounded vocational education in the craft of roofing and waterproofing.

#### Selection of Apprentices

Under authority given in the apprenticeship standards, the local JAC or JATC approves applications for apprenticeship on the basis of the following: (1) minimum basic education (high school graduation or G.E.D. equivalent test administered by the school as required in some areas); (2) a qualifying test for apprentices and other trade tests as required by the local JAC or JATC; (3) age—eighteen years minimum; and (4) employment opportunities (governed by the needs of industry in the area at the time of application).

The Civil Rights Act of 1964 makes unlawful the practice of discrimination, in matters of education, employment, housing, and voting, against any individual because of race, religion, sex, or national origin. Among its provisions the act requires affirmative nondiscriminatory selection of apprentices by industry joint committees.

Clearly, the best interests of the nation are served if equal employment opportunities are afforded to all; and on this point labor, management, and government are in full agreement. Many social, economic, and educational problems remain to be solved before the

goal of equal economic opportunity for all can be fully achieved; but progress toward this end is being made.

## Individual Apprenticeship Agreements

The apprenticeship standards require that each apprentice sign an apprentice agreement with the joint apprenticeship committee. In signing the apprentice agreement, the apprentice enters into a contract of indenture with the joint apprenticeship committee, which acts on behalf of the employer and the union. As parties to this contract, the apprentice, the employer, and the union assume specific responsibilities with regard to the apprenticeship.

### Responsibilities of the Apprentice

The apprentice has the following basic responsibilities under the agreement:

1. To perform diligently and faithfully the work of learning the trade
2. To comply with the training schedule
3. To make satisfactory progress on the job
4. To maintain good personal relationships with the employer and with fellow employees
5. To attend related and supplemental classes of instruction regularly and make satisfactory grades
6. To report to the joint apprenticeship committee any major deviation from the training schedule or violation of the training schedule
7. To keep records of his or her on-the-job training and classroom attendance and progress as required by the joint apprenticeship committee
8. To inform the employer, the union, and the joint apprenticeship committee if he or she changes his or her address or if he or she is unable to work or attend related instruction classes

### Responsibility of the Employer

The employer is responsible for providing on-the-job training for the apprentice. The best apprentice training occurs in shops or on projects where the employer knows the value of training and gives emphasis to it throughout his or her organization. The superintendent, the supervisor, and the journey-level worker must understand that they all have a responsibility in the training of apprentices. Successful businesses are built on planning and training for the future, and sound apprenticeship training requires that the employer assume responsibility for turning out all-around skilled workers.

### Responsibility of the Union

One of the fundamental purposes of the union is to provide industry with skilled, competent workers. To ensure a continuing supply of qualified roofers, the United Union of Roofers, Waterproofers, and Allied Workers actively supports apprenticeship, admits qualified persons to union membership as apprentices, and assists in the training of the apprentices.

### Discipline

Roofing and waterproofing apprenticeship is a voluntary program in which all parties—the union, the employer, and the apprentice—accept mutual obligations. Self-discipline is inherent in all aspects of the program. Authority to impose sanctions against those who violate the rules is vested in the local joint apprenticeship committee or local joint apprenticeship and training committee, subject to appeal through the State Administrator of Apprenticeship. All approved standards establish this "chain of command."

The local joint apprenticeship committee or joint apprenticeship and training committee has the authority to discipline apprentices for failing to attend related instruction classes or for disrupting instruction in a class. By this authority the committee may terminate an apprentice's indenture.

The local joint apprenticeship committee or joint apprenticeship and training committee also has authority to deny individual employers the right to employ apprentices when such employment would not provide suitable on-the-job training or when wages, hours, or working conditions are in violation of the collective bargaining agreement of the apprenticeship standards.

### Labor Laws and the Apprentice

All federal and state laws, rules, and codes that apply in general to the labor force apply also to apprentices. Some federal laws of special concern to workers are the Fair Labor Standards Act, the Davis-Bacon Act, the Walsh-Healy Act, the Taft-Hartley Act, and the Landrum-Griffin Act.

### The Fair Labor Standards Act

The Fair Labor Standards Act establishes minimum wages and maximum hours for workers engaged in interstate commerce or in the production of goods for interstate commerce. Although this law does not directly affect many workers in the skilled trades, it

does tend to raise wages and decrease working hours for workers in general.

#### The Davis-Bacon Act

The Davis-Bacon Act provides that the wage scales established for private industry in an area will apply for federal public works projects in that area. The act also requires that contractors for federal public works projects submit evidence of established apprentice–journey-level worker ratios and wage rates, that each apprentice employed on such a project be certified to the contracting agency, and that certain fringe benefits be provided for all workers, including apprentices, who are employed on projects covered by the act.

#### The Walsh-Healy Act

The Walsh-Healy Act establishes standards for pay and working conditions for persons employed under federal government contracts. This legislation, like the Fair Labor Standards Act, has the effect of promoting better working conditions and raising pay levels not only for those directly affected but also for workers in general.

#### The Taft-Hartley Act

The Taft-Hartley Act (the Labor-Management Relations Act of 1947) is an amendment to the National Labor Relations Act of 1935. The National Labor Relations Act as amended guarantees the right of workers to organize and bargain collectively with their employers, permits the existence of a union shop, prohibits a closed shop, and allows the President to impose a cooling-off period before a strike or lockout affecting national health or safety can be called. The Taft-Hartley Act contains a number of other provisions, some of which are considered controversial, but all of which are of concern to the worker in his or her relations with his or her union and employer.

#### The Landrum-Griffin Act

The Landrum-Griffin Act (the Labor-Management Reporting and Disclosures Act) requires labor organizations and employers to report regularly on certain of their activities; sets standards regarding union elections, the handling of union funds, and the qualifications of union officers, requiring that such officers be bonded; and prohibits secondary boycotts, certain kinds of strikes and picketing, and certain kinds of labor contracts.

### Equal Opportunity Regulations

Title 29, *Code of Federal Regulations,* Part 30, was enacted as a national plan to promote equality of opportunity in apprenticeship by prohibiting discrimination based on race, color, religion, national origin, or sex in apprenticeship programs. It requires affirmative action by joint apprenticeship committees and apprenticeship programs to provide equal opportunity in the selection of applicants and their training. It also applies to conditions of employment and procedures for review of apprenticeship programs to ensure compliance, processing of complaints, and deregistering of apprenticeship programs that do not comply.

A similar statewide plan, called the California Plan for Equal Opportunity in Apprenticeship, is nearly identical with the national plan and is approved by the United States Department of Labor as being consistent with the federal regulations. Under the provisions of 29 *CFR* 30 and the California Plan, apprenticeship programs are required to take affirmative action to provide equal opportunity in apprenticeship, report periodically the minority participation in their training programs, and coordinate their equal-opportunity efforts with those of other equal-opportunity programs.

**Study Assignment**

**Review the apprenticeship standards adopted by your joint apprenticeship committee or joint apprenticeship and training committee.**

TOPIC 3

# Apprenticeship and the Public Schools

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Discuss the differences between on-the-job training and related instruction classes and the purposes and importance of both.**
- **Discuss the role of the California Department of Education in the apprenticeship program.**
- **Identify the responsibilities of the apprenticeship educational advisory committees.**

MODERN apprenticeship is a combination of two interrelated types of training: (1) experience obtained on the job under the guidance and supervision of workers at the journey level; and (2) related instruction obtained in classes held in the local public schools. The responsibility for providing well-rounded on-the-job training is assumed by industry. By state law, the public schools are responsible for providing the related instruction needed in an apprenticeship program.

## Related Instruction Classes

Most related instruction classes are conducted in high schools, adult schools, and community colleges, usually in the evening. (In some instances classes are conducted in industry-funded training centers.) The instruction is given by a journey-level worker who is experienced, well informed, and highly skilled in his or her trade and who also holds a California vocational teaching credential that he or she has earned by meeting state requirements. The instructor follows the course outline and uses the instructional materials prescribed by the industry he or she represents.

The school district provides the classroom facilities, the necessary equipment and materials, and the instructor for the related instruction class. Like any other teacher, the instructor is an employee of the school district.

### Local Educational Advisory Committees

To ensure that the related instruction classes will be an effective part of the total apprenticeship program, a school district that offers this instruction obtains the advice and assistance of industry representatives in planning and operating the classes. The school district may appoint an apprenticeship educational advisory committee of its own choice for this purpose, but usually the district relies on the local joint apprenticeship committee to provide the needed advice and assistance.

The school district usually relies to a great extent on the local educational advisory committee for suggestions and recommendations regarding such matters as (1) the best available candidates for employment as instructors in the related instruction program; (2) the facilities, equipment, and supplies that are needed to make the program fully effective; (3) the instructional procedures that may be used to best advantage in the program; and (4) ways in which disciplinary problems may be handled to the best advantage of all who are involved—the individual, the industry, and the school.

### The California Department of Education

The California Department of Education contributes in many ways to the apprenticeship instructional programs conducted by the public schools. The responsibilities of the Department of Education include the following:

- Helping the schools to establish and maintain related instruction programs for the trades
- Coordinating the related instruction programs offered by the various school districts
- Working cooperatively with each industry to develop course outlines and instructional materials for use in the related instruction program
- Editing and publishing workbooks, testbooks, and other instructional materials that are developed cooperatively by the Department and the industry
- Assisting and advising each industry in the selection of additional instructional materials for use in conjunction with those published by the Department

- Conducting training programs for instructors and coordinators for the related instruction program
- Helping apprenticeship committees to find the best answers to statewide educational problems relating to apprenticeship
- Providing school districts with part of the funds needed to cover the cost of related instruction

The California Department of Education meets these responsibilities primarily through the Career–Vocational Education Division.

#### State Educational Advisory Committees

Each industry that conducts an apprenticeship progam for which the public schools provide related instruction has a state educational advisory committee representing labor and management. Each such committee has statewide responsibility for advising and assisting the Career–Vocational Education Division in matters such as the following:

- Developing course outlines for the related instruction required by the industry the committee represents
- Preparing instructional materials to be used in the related instruction classes
- Selecting the textbooks and other materials to be used in conjunction with the instructional materials prepared by the Department of Education
- Formulating policies for conducting the related instruction program and determining the practices that will be followed to make policies effective

The State Joint Roofing Industries Apprenticeship Committee, which acts under the direction of the Education Advisory Committee for the Roofing Industry, is composed of labor and management representatives and advisers appointed by the joint apprenticeship committees in the collective bargaining areas in the state. This committee has within its membership a wealth of knowledge and experience in roofing and construction; and it is always alert for new ideas and information from trade associations, manufacturers, and others in the industry. It is, therefore, well equipped to advise and assist the Career–Vocational Education Division in the task of providing an up-to-date, efficient, and effective related instruction program for roofing apprentices.

### Importance of Related Instruction Classes

Every apprentice must enroll in the related instruction courses that are prescribed for the trade in which he or she is serving his or her apprenticeship. The apprentice must attend class regularly, complete all assignments, and pass the tests that are given periodically throughout the course and at the end of the course. Regular and prompt attendance is essential for learning and for maintaining a place in the apprenticeship program. Absence is excused only for illness or other serious circumstances beyond the apprentice's control.

Sometimes, an apprentice must work in an area where attendance at the required classes is impossible. In this case, the joint apprenticeship committee and the school may provide for the apprentice to complete the prescribed assignments by correspondence; however, such an apprentice still must report to a designated place to take the required final tests under the supervision of a credentialed instructor.

### Study Assignment

**Read the foreword and preface of this workbook for useful background information on roofing and waterpoofing.**

TOPIC 4

# Collective Bargaining, Wages, and Benefits

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Define collective bargaining.**
- **Describe the effects of collective bargaining.**
- **List the items required by law to be included on an employee's payroll check stub.**
- **Describe the benefits of the social security program.**
- **Describe the primary benefits of state unemployment insurance and workers' compensation insurance.**

## The Collective Bargaining System

After passage of the Wagner Act (the National Labor Relations Act) in 1935, the negotiation of written contracts between unions and employers became general practice. Representatives of labor and management meet to negotiate these contracts in a process known as collective bargaining.

Widespread acceptance of collective bargaining had an immediate stabilizing effect on the nation's industries. Labor relations were improved, and a better climate of work resulted for employers and employees alike.

## The Master Labor Agreement Concept

The United Union of Roofers, Waterproofers, and Allied Workers has always granted its affiliated local unions a large measure of autonomy (self-government) in their day-to-day operations. Since the inception of collective bargaining, labor relations in the construction industry have been governed by a wide variety of locally negotiated contracts. A few unions, however, negotiate together to establish a multiunion agreement. The multiunion negotiation team meets with representatives of a group of employers (an association) to formulate a uniformly applied master labor agreement between the unions and the employer association within a defined geographical area.

Labor agreements are usually negotiated for a contract period of one year or more, with provision for interim openings (additional negotiations) for specific and limited purposes. These agreements are registered and filed with all appropriate state and federal agencies. They are lawful contracts, binding on all the signatory parties and enforceable in the courts.

### Amendments to the Agreement

Prior to the expiration date of the existing master agreement, labor and management representatives meet in negotiating sessions to arrive at a new agreement, which is usually an amended version of the existing master agreement.

The procedure to be followed in amending the master agreement varies in each contract area, but the general practice in each area is to serve notice of a desire to amend. This is usually done by the union. The employers then meet among themselves to select their negotiators and define their strategy. The union holds a conference, or a series of conferences, to formulate its demands and appoint a negotiating committee. The bargaining parties then meet to establish a schedule of negotiating sessions.

### Contents of the Agreement

The collective bargaining agreement executed by the employers and the union establishes the wages, hours of work, overtime pay, working conditions, and fringe benefits for the roofers and waterproofers in the contract area. It also contains provisions for the settlement of disputes and the carrying out of grievance procedures, and it provides the basis for roofing and waterproofing apprenticeships in the contract area.

## Collective Bargaining Results

As a result of collective bargaining, labor relations in California's construction industry have become

stabilized; and a high degree of uniformity in wages, hours, and working conditions has been achieved for roofers and waterproofers throughout the state. Also, the master agreements in the various contract areas include provisions for health and welfare plans, pension plans, and vacation plans. These plans are financed by employer contributions, on a "cents-per-hour-worked" basis, to trust funds that are administered by boards of trustees made up of labor and management representatives in equal numbers.

#### Health and Welfare Plans

In the early 1950s industry-paid health and welfare plans were negotiated in roofers' collective bargaining agreements in each contract area of the state. These plans provide medical, surgical, and hospital insurance for the roofers and their families, plus life and double-indemnity insurance for the roofers themselves. Depending on contract negotiations, the plan may include insurance coverage for dental work, prescription drugs, and other health needs.

#### Pension Plans

Industry-paid pension plans for the roofers were negotiated in each contract area in the late 1950s. Such features as liberal eligibility rules, liberal benefits backed by large financial reserves, provisions for disability retirement and early retirement, vesting rights, reciprocity agreements, and prior-service credits make these plans a major factor in the roofer's security.

#### Vacation Plans

In the early 1960s vacation plans were negotiated as part of the master agreements for the various contract areas. These plans differ somewhat from contract to contract, but basically they provide for employer contributions to a trust fund that enables the employee to have a paid vacation once a year.

#### Apprenticeship and Training Funds

The master agreement may provide for employer contributions to a trust fund for sponsoring and administering the apprenticeship and training programs in the contract area. These contract-area programs are supervised by local joint apprenticeship committees and are coordinated by a statewide joint apprenticeship committee. This results in a high degree of uniformity in roofing apprenticeship throughout the state.

### The Payroll Check Stub

California's *Labor Code* contains the following statement requiring payroll accounting to the employee:

> Every employer shall semimonthly or at the time of each payment of wages furnish each of his employees either as a detachable part of the check, draft, or voucher paying the employee's wages, or separately, an itemized statement in writing showing: (1) all deductions; (2) the inclusive dates of the period for which the employee is paid; (3) the name of the employee or his social security number; and (4) the name of the employer; provided, all deductions made on written orders of the employee may be aggregated and shown as one item. (*Labor Code*, Section 226)

The employee's payroll check stub provides a record of his or her earnings for the payroll period, amounts withheld for income taxes and social security, and other authorized deductions. The stubs should be kept because they may become extremely important records if the employee questions a payroll item or attempts to establish his or her rights in any matter relating to wages and benefits.

### Wages

The employee should make sure that the payroll period, hours worked during that period, overtime (if any), gross earnings, deductions, and net pay shown on his or her payroll check stub are correct. If there is an error, the employer, timekeeper, or paymaster should be informed without delay. Any dispute relating to a payroll accounting matter should be reported to the business representative of the union if it cannot be satisfactorily resolved.

Sections 201, 202, 203, 206, 208, 212, 222.5, 223, 1126, 1170, 1771, and 1775 of the *Labor Code* were written specifically to protect the worker's rights to wages. Every worker should be familiar with these provisions of the law. The employer is required to acquaint himself or herself with California's labor laws as a condition of obtaining a contractor's license.

### Federal and State Income Taxes

Federal and state income tax deductions based on gross earnings and claimed exemptions are withheld from the employee's pay, and the amounts withheld are

shown on the payroll check stub. Also, the employer is required by law to provide the employee with an accounting of his or her total gross earnings and the amounts withheld for income tax and social security for the calendar year. This information must be provided on a W-2 form by January 31 of the following year.

## Social Security

The employer and the employee jointly contribute to the federal Old Age, Survivors, and Disability Insurance Program (OASDI), which is generally referred to as "social security." An OASDI deduction is made from the employee's wages each payday. The employer matches the deduction and sends the combined amount to the Internal Revenue Service, where it is credited to the employee's social security account.

### The Social Security Number

The employee's social security number is the key that permits electronic data processing equipment to be used to credit his or her account and keep it up to date. The social security number is also used for federal and state income tax purposes and to identify the employee's health and welfare, pension, and vacation accounts. For these reasons, the employee should make sure that his or her social security number is correct on all forms and records where it is needed.

## Retirement Benefits

To be eligible for retirement benefits under the current provisions of the social security law, the worker must be fully insured and at least sixty-two years of age. A worker is fully insured under the social security law when he or she has completed the required number of calendar quarters of covered employment (from six to 40 quarters, depending on the year in which he or she will be sixty-two). Monthly payments can also be made to an insured retired worker's wife or husband if she or he is at least sixty-two years of age; to an insured retired worker's wife under sixty-two if she is caring for his child who is under eighteen or disabled and receiving benefits based on the retired worker's earnings; to an insured retired worker's unmarried children under eighteen (age twenty-two, if full-time students); and to an insured retired worker's unmarried son or daughter who is eighteen or older and who was severely disabled before age twenty-two and continues to be disabled.

Retirement benefit amounts depend on the retired worker's average earnings under the social security program, his or her earnings (if any) during retirement, and the age at which he or she elects to start receiving benefits. (A worker retiring between the ages of sixty-two and sixty-five will receive smaller monthly payments than he or she would if he or she retired at age sixty-five.)

### Survivors' Benefits

If a worker is fully insured at the time of his or her death, his widow or her widower can receive social security benefits if she or he is sixty or older or if she or he is caring for dependent children who are eligible for benefits based on the deceased worker's record. The law also provides benefits for the deceased worker's dependent children and dependent parents (if the latter are sixty-two or older). Benefits may be available to certain survivors even if the worker was not fully insured at the time of his or her death. In addition to monthly payments for survivors, a small lump sum payment may be made after the worker's death.

### Disability Payments

If a worker becomes disabled before age sixty-five and is unable to work for a long time, he or she and certain members of his or her family may become eligible for disability payments under the social security law. To qualify, the worker must have social security credits for a prescribed number of years of work. The younger the disabled worker, the fewer credits he or she needs to qualify for disability benefits. For a worker disabled before age twenty-four, for example, the

requirement is one and one-half years of work credits in the three-year period preceding his or her disability. If a worker becomes disabled at age thirty-one or later, generally he or she must have credit for at least five years of work during the ten years ending when he or she became disabled. The disability must prevent the claimant from working and must be expected to last (or has lasted) at least 12 months, or is expected to result in death.

#### Medicare

The social security program has been expanded to include medical and hospital benefits for those who qualify (mainly persons sixty-five years of age or older, but certain disabled persons under sixty-five also qualify).

#### Keeping Informed

The social security law has undergone many changes over the years. Answers to any questions about the current program can be obtained at local offices of the Social Security Administration, U.S. Department of Health and Human Services.

### State Unemployment Insurance

The construction industry is of basic importance to the nation, and it must have a continuing supply of skilled workers. Consequently, the long-term prospects for employment in the building trades are good. The pace of the industry is affected by economic trends, however, and occasional unemployment is one of the risks of construction work. In California, as in other states, an unemployment insurance program provides eligible unemployed workers with cash benefits to offset partially their lost income. The program is financed by premiums paid to the Unemployment Insurance Trust Fund by the employers on behalf of the employees. Eligible unemployed workers are paid weekly benefits from the trust fund. The benefit amounts depend on the claimant's earnings during a 12-month "base period," which is established on the basis of the month in which the claim starts. For example, for a claim made in February, March, or April, the base period would be the 12-month period that ended on the previous September 30. To be eligible for unemployment benefits, the claimant must be physically able to work, actively seeking work, and able to accept work.

A roofer who has been laid off should sign the "out-of-work" list at the union office. Then, if work is not available, he or she should, as soon as possible, file a claim for unemployment benefits at the nearest field office of the California Employment Development Department. While at the employment office, he or she should obtain copies of pamphlets that explain the unemployment insurance program in detail.

#### State Disability Insurance

Workers who are covered by California unemployment insurance are also covered by disability insurance, for which a deduction is made from their pay. Disability insurance is intended to provide the worker with some income during periods when he or she cannot work because of a nonoccupational illness or injury. Employees are insured either under a state plan or under a state-approved voluntary plan with a private insurance company. Just as employers pay for unemployment insurance through a tax on wages, employees pay for disability insurance through contributions based on their earnings. These contributions are withheld by the employer and paid either to the state or to the private insurance company, depending on which type of coverage is in force.

### Workers' Compensation Insurance

The employer is required by law to insure his or her employees against the industrial hazards of employment. A system of workers' compensation insurance has been established for this purpose. The employer has the option of carrying this insurance with the state's Compensation Insurance Fund or with a private insurance company, which must provide benefits equal to or greater than those of the state fund.

The basic purpose of the California workers' compensation law is to ensure that an employee who suffers an industrial injury—as well as those who depend on him or her—will have adequate means of support while he or she is unable to work and that provision will be made for any medical treatment he or she may need as a result of the injury. Workers' compensation insurance provides for medical treatment and income for workers who are injured on the job, regardless of the cause of the injury.

The employer or his or her insurance carrier arranges for the needed medical and hospital services. The weekly income benefits are paid directly to the injured employee during the period of his or her disability. The benefit amounts are based on the employee's earnings and whether the disability is

temporary or permanent. If the industrial injury results in the worker's death, a substantial benefit is payable to those who were dependent on the worker for support.

#### Reporting Injuries and Making Claims

The worker should notify his or her employer or his or her immediate supervisor promptly in the event of an on-the-job injury or claim of injury. If the worker fails to give such notice within 30 days after being injured, his or her claim for compensation could be denied.

The employer is required by law to provide necessary medical treatment and report the injury to his or her insurance company and to the state. Normally, the employer or insurer then contacts the worker and arranges for the payment of benefits; however, if the worker finds that payments are not forthcoming or are unreasonably delayed, or if he or she believes that his or her workers' compensation benefits have not been accurately determined, he or she can get help by bringing the matter to the attention of the Workers' Compensation Division.

#### Keeping Informed

Additional information about the workers' compensation law can be found in the pamphlet *Highlights of the California Workers' Compensation Law*, which can be obtained at any office of the Workers' Compensation Division. Assistance and information on obtaining workers' compensation benefits or any other benefits discussed in this topic can also be obtained from the business office of the local union, the apprenticeship coordinator, or a member of the joint apprenticeship committee.

#### ERISA

In 1974 Congress passed a comprehensive pension reform act, known officially as the Employee Retirement Income Security Act of 1974 (ERISA). The provisions of this act include rules on pension funding, registration, plan termination, insurance, reporting, fiduciary responsibility, and guidelines for employer-employee participation and the availability of information for the participants.

The intent of ERISA is to provide protection and security to all participants in fringe-benefit pension plans established for employees. The roofer should be aware of the eligibility requirements for his or her participation in the negotiated pension plan, the contributions made by the employer in his or her behalf, and the benefits that he or she will receive from any fringe contributions that are part of his or her total wage package.

### Study Assignments

1. Read the roofers and waterproofers' agreement for your contract area, which is available from the local union. Detailed information on the fringe benefit plans that have been negotiated in the contract area is also available from the local union.
2. Obtain and study pamphlets describing the programs discussed in this topic.

TOPIC 5

# Safety in the Industry

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Identify the primary purpose of the federal Occupational Safety and Health Act of 1970.**
- **Identify the primary functions of CAL/OSHA.**
- **Identify items of clothing appropriate for use on the job.**
- **Discuss ways to prevent slips and falls.**
- **List the primary reasons why roofers are frequently burned with hot asphalt or pitch.**
- **Describe the correct procedure for lifting heavy objects.**
- **Identify the safety precautions one should take in handling hot asphalt or pitch.**
- **Discuss the major provisions of Article 30, "Roofing Operations and Equipment" of the *Construction Safety Orders*.**

## The Williams-Steiger Occupational Safety and Health Act of 1970

On December 29, 1970, Congress passed into law the Williams-Steiger Occupational Safety and Health Act (OSHA), which is intended to preserve human resources and to ensure so far as possible safe and healthful working conditions for every worker in the nation. The responsibilities for administration and enforcement of OSHA are vested primarily in the Secretary of Labor and the Occupational Safety and Health Review Commission, a quasi-judicial board of three members appointed by the President.

### Responsibilities of Employers

Under the provisions of the Occupational Safety and Health Act, every employer must (1) furnish his or her employees a place of employment that is free from recognized hazards that could cause serious injury or death; and (2) comply with the safety and health standards issued by the Department of Labor. The term *hazards* is defined as *all* hazards, regardless of whether they are cited specifically in a standard, regulation, or order. Employers who do not comply with the provisions of the act may be cited for violation and fined.

### Responsibilities of Employees

Each employee must comply with the safety and health standards, regulations, and orders that are issued under the act and that are applicable to his or her personal conduct on the job.

## CAL/OSHA

The Williams-Steiger Occupational Safety and Health Act provides that individual states may develop their own plans for meeting the requirements of the act. Approval of a state's plan for permanent management of health and safety programs within the state is contingent on the Department of Labor's determination that the state's requirements will be at least as effective as those established under the federal act. Such a plan was provided in California with the passage of the California Occupational Safety and Health Act of 1973 (CAL/OSHA). The Secretary of Labor monitors the state plan and can, on finding substantial failure by the state to carry out its plan, withdraw approval and invoke federal regulations.

The administration of the CAL/OSHA plan is the responsibility of the California Agriculture and Services Agency. All authority to make and enforce rules is vested in the California State Department of Industrial Relations through its Division of Occupational Safety and Health.

### Responsibilities of Employers

Each employer in California shall furnish a place of employment that is safe and healthful for his or her employees. The employer shall furnish and require the

use of necessary safety devices and safeguards and shall adopt and use work practices and processes that are adequate for the safety and health of his or her employees.

Manufacturers are required to furnish information concerning hazardous materials by means of material labels and OSHA Material Safety Data Sheets (MSDSs). The latter are two-page forms completed by the manufacturer that provide the following kinds of information about the product: trade name and chemical name; physical properties; fire and explosion hazards; hazardous ingredients and associated health hazards (including exposure limits, effects of overexposure, and first-aid procedures); required safety equipment; and special precautions to be taken with regard to handling and storage, spills and leaks, and ventilation of the workplace.

Employers are required to give their employees prejob instruction regarding MSDS information and any special safety requirements of the job.

#### Responsibility of Employees

Each employee, as well as each employer, must comply with safety and health standards and with all rules, regulations, and orders that are applicable to his or her own actions and conduct.

### National Institute for Occupational Safety and Health

The Secretary of Health and Human Services, in consultation with the Secretary of Labor and other agencies, has the authority to conduct research, experiments, and demonstrations; publish a list of toxic materials; develop criteria for establishing safety and health standards; make inspections; require monitoring and physical examinations; and the like. To the extent feasible, these activities are to be carried out by the National Institute for Occupational Safety and Health (NIOSH), a component of the Department of Health and Human Services.

In 1976, for example, NIOSH and CAL/OSHA began a joint study of the effects of smoke from asphalt and coal-tar pitch on roofers' lungs and skin. This study is being conducted under the direction of the Division of Occupational Safety and Health.

### The Importance of Safety

Every employee owes it to himself or herself, his or her family, his or her coworkers, and his or her employer to work in the safest manner possible. Unless safety principles and practices are faithfully observed every day, the time and effort that an apprentice puts forth in learning the trade could become a tragic waste. Taking the time now to learn about job safety can mean the difference between life and death or between living a normal, productive life and having to struggle for a decent living as a result of a physical handicap.

By their very nature, occupations within the construction industry are extremely hazardous.

Among the building trades in California, the roofing industry has the highest ratio of disabling work injuries and illnesses covered under workers' compensation insurance per 1,000 workers. ("Disabling work injuries and illnesses" are defined as those resulting in the loss of one full day of work or more.) Four types of accidents account for a vast majority of the lost-time injuries and illnesses of roofers in California: slips and falls; strains, sprains, or overexertion; being struck by an object or colliding with an object; and burns.

### California's Industrial Safety Orders

The Division of Occupational Safety and Health establishes minimum standards of safety, or safety orders, for all phases of industrial activity. The *General Industry Safety Orders* are general in application; the *Construction Safety Orders* apply specifically to building construction. Proposed safety orders or revisions of safety orders are adopted only after they have been fully studied by safety engineers, labor leaders, employers, workers, and other interested persons.

The *Construction Safety Orders*, which are published in convenient handbook form, establish minimum safety standards for work connected with the construction, alteration, painting, repair, construction maintenance, renovation, removal, or wrecking of any fixed structure or its parts. The handbook includes safety regulations and specifications affecting every construction worker and employer, and a copy should, therefore, be available on the job at all times.

If a worker is directed to perform work that would violate the safety orders and create a real and apparent hazard, the worker should refuse to perform the work. The *Labor Code* provides that no employee shall be laid off or discharged for such a refusal and that if discharged for this reason, the worker may sue the employer for wages lost.

It is a misdemeanor in California for any person to remove or displace safety devices or warning notices or

to interfere with the use of any method or process adopted for the protection of the workers or other persons. Also, if a worker who suffers an industrial injury is proved to have been guilty of serious and willful misconduct relating to the accident, the workers' compensation benefit to which the worker would be entitled may be reduced. Willful misconduct has been held to mean the failure to observe reasonably enforced safety rules or negligence in using protective safety devices.

## Causes of Accidents

An accident is an unplanned and unforeseen occurrence that interferes with the orderly progress of an activity or interrupts the orderly progress of an activity. By this definition accidents do not necessarily involve injury or loss of life; but, in fact, they all too often do. Every accident should be analyzed to determine why and how it occurred and what steps should be taken to prevent the occurrence of similar accidents in the future. Learning from past accidents and putting the knowledge gained to work for more effective safety planning are important steps in accident control.

Accidents are caused for the most part by unsafe conditions, unsafe acts, or some combination of these two hazards.

### Unsafe Conditions

Unsafe conditions on the job site may be present in the form of equipment that is poorly designed and poorly constructed, improperly installed, or badly maintained. Unguarded saws, defective or wrong hand tools, and poor housekeeping are common factors that make for unsafe working conditions.

### Unsafe Acts

Unsafe acts are violations of safe working practices. Wearing improper clothing on the job, operating machinery without the required guards, and lifting or carrying with the back bent are all examples of unsafe acts.

Unsafe conditions and unsafe acts are each threats to the worker's safety, but it is usually a combination of these hazards that causes industrial accidents. A wheelbarrow with cracked or loose handles (unsafe condition) may not figure in an accident until a worker attempts to wheel a heavy, unbalanced load in it (unsafe act). Again, a power saw with an unguarded blade is not likely in itself to cause an accident, but a severe injury can result if a worker disregards the unsafe condition of the machine and as a result gets his or her hand in the way of the blade.

Employers can reduce accidents by correcting unsafe working conditions, making job analyses to include safe work practices in job instruction, and carrying out regular and careful inspections of equipment and job premises. All construction employers are required to inaugurate and maintain accident-prevention programs that make use of safety committees, group safety meetings, and individual safety instruction.The trainee is urged to support and participate in such programs, to learn the basic principles of safety and the safety rules that apply in his or her work, and to observe safety rules and principles faithfully.

## Safety Practices

The importance of safety principles and regulations must not be minimized, but safety on the job cannot be achieved merely by having at hand a book of safety rules. Accident control is dependent on the intelligent and conscientious application and practice of the rules; and this in turn is dependent on education, vigilance, and the cooperation of every person on the job.

### The Penalties for Unsafe Practices

What is it like to be blind? Spending a few moments with his or her eyes tightly closed should convince any worker or trainee that this would be a most undesirable way to spend the rest of his or her life. What happens to an injured worker's family if the worker must spend weeks or perhaps months in a hospital and creditors begin to clamor for payment? How difficult is it to learn to walk with only one good leg, or to eat, dress, or work with only one hand? Are these questions important only to the other person? Do accidents happen only to them?

The new trainee should not be deceived about the penalties of losing when gambling with safety. The stakes are high: eyes, hands, arms or legs, perhaps even life, and always his or her family's welfare.

The worker who is willing to take the chance may say, "They're my eyes, and I have a right to risk them if I feel like it!" But what about his or her fellow workers whose safety is also being put on the line? And what about the cost to the community—costs that run to hundreds of millions of dollars annually in the United States? And most of all, what about his or her family if,

because of a disabling injury, his or her potential lifetime earning power suddenly drops from over $500,000 to a fraction of that amount?

The new trainee reading this topic might say at this point, "What are they trying to do—scare me?" The answer is yes; a "scared" worker—that is, one with a never-failing awareness of job hazards and respect for them—is a safer worker. It is hoped that the trainee will never have to witness a severe industrial accident, much less be the victim of one; but the sickening sounds of stalling machinery mixed with screams as a person's hand and arm are mangled in the gears, or the splinter and thud of a person falling 30 feet (9.1 metres) into a pile of scrap lumber, are sounds that can never quite be forgotten. And a worker who has heard someone scream as a power saw cuts a hand off will be scared of saws and will be safe with them for the rest of his or her life.

## Basic Safety Rules

Gambling with safety is certainly a losing game. Workers in any trade are exposed to a variety of hazards and dangers during the course of their work; but they can greatly reduce the chances of suffering death or serious injury on the job by knowing, observing, and living with a few basic safety rules:

*Be cautious, and keep your mind on your work.* Accidents often happen to the complacent worker who knows the job so well that he or she permits his or her mind to wander from the work. A safe worker is a "worry wart" who is always looking ahead to see what might cause an accident: Could the tool or his or her hand slip? Could his or her hands slip past the machine's safety guards? Is that ladder secure? What about other people on the job—in what ways could they cause accidents? The safety-conscious worker is always thinking about such things. He or she never assumes, for example, that machinery, tools, and guards are in good working order; he or she checks such things to be sure they are safe.

### Specific Safety Rules for Construction Workers

The foundation of good safety practice is built on a knowledge of basic safety principles and rules, but these general rules must be made specific if they are to be of practical value. In other words, they must be related to actual conditions on the job. The specific safety rules that are presented in the following paragraphs are important. Violations of them figure in many industrial accidents. The trainee who does not read them carefully, think about them, and live them will sooner or later lose the safety game—a game that he or she cannot afford to lose.

*Practice good housekeeping on the job.* Good housekeeping is essential for safety on the job.

Stairways and ramps must be kept clear of materials, tools, ropes, electrical cords, and trash. Work areas must be kept clean and clear of unneeded materials and equipment. Oil, grease, mud, or other substances that could cause falls must be cleaned up immediately. Any material or object that could be stumbled over should be removed from the work area or should be guarded if it cannot be removed. Forms and scrap lumber with protruding nails should be kept away from work areas and passageways. Protruding nails should be pulled out or bent back. The ground within 6 feet (1.8 metres) of a building or work area must be leveled, and depressions must be filled in or guarded. Open ditches must be bridged.

*Use care in handling and piling materials.* Incorrect handling and piling of materials makes for accidents. Materials should be stacked so they cannot be accidentally tipped over.

*Employ safe methods for lifting.* Unsafe methods of lifting, lowering, and carrying materials can cause strains, sprains, and hernias. If the strain is exceptionally severe, dislocations and even fractures can result. When coupled with unsafe working conditions, unsafe methods of lifting and carrying can result in bad falls or smashed fingers or toes.

A worker should know his or her lifting limitations. He or she should seek help from a fellow worker or—where possible—employ mechanical means for lifting and conveying heavy loads. When a worker must lift material alone, he or she should follow the steps given in Fig. 5-1.

Coordinated teamwork is necessary when two or more workers are to work together in lifting or carrying. Work partners should be of similar stature. The direction they are to move, the timing of the lift, and the timing of placing and releasing the load must be agreed on; but only one member of the team must give directions. Work partners should keep in step when carrying the load.

*Be your brother's or sister's keeper.* The responsibility for safety is more than just an individual matter; it

must be shared by everyone on the job. When a careless worker gambles with safety, the safety of coworkers is put on the line, too. The wise worker does not fall into the habit of letting the other person worry about safety.

*Be neat.* "Good housekeeping on the job means safety" is a statement that everyone would agree with but that too few workers seem really to believe. A quick look around almost any job site will bear this out. Yet, it has been demonstrated time and again that orderly work areas are an important factor in keeping accident rates down.

*Make safety a lifetime concern.* The results of faithful attention to safety are largely unseen, but the results of neglecting it are often tragically apparent. Safety is something every person must work at throughout life, probably without ever seeing the results. The worker should remember that just by staying even, by not losing anything, he or she is winning the safety game.

*Make safety rules live.* Simply knowing the safety rules of his or her trade will not make the worker safe. Safety rules merely warn, "These are things that commonly happen to beginners and dreamers—BEWARE." Unless the worker makes the rules live through actual practice, they will remain nothing more than dead words.

*Be careful with hand tools.* Incorrectly used or poorly maintained hand tools are dangerous. The chief hazards associated with hand tools are the following: being struck by the tool being used or by a tool used by another worker; being struck by chips from a tool or from the material it is used on; being struck by a tool that has come off its handle; and stumbling over or being cut or hit by a tool carelessly left on the floor or ground.

A worker is in danger of being injured by the tool he or she is using if it is the wrong tool for the job, if it is the right tool used in the wrong way, or if it is defective. Before swinging a hatchet or similar tool, the

1. Size up the load, the footing, and the place where you are to put down the load. Be sure that the area is not slippery or cluttered, that you have room to walk with the load, and that you have a clear view.

2. Adopt a comfortable stance that will permit you to lift as nearly straight up as possible. Place one foot a short distance in front of the other, close to the load. This provides a good base and helps prevent undue strain on the abdominal muscles.

3. Crouch. Bend the knees, but keep the back straight and the head up. Get a firm grip on the object to be lifted. If necessary, bend the knees to get closer to the object.

4. Raise the weight gradually by straightening the legs, taking the strain on the leg and shoulder muscles, not on the back muscles. Do not twist the body or move jerkily.

5. Carry the load with the weight so distributed that you will not be thrown off balance. Carry the load in such a way that your view will not be obstructed.

6. In lowering the load, bend the knees and, keeping the load close to the body and your back straight, lower with arm and leg muscles.

**Fig. 5-1. Correct procedures for lifting alone**

worker should ensure that no other person is close enough to be struck. Stand away from other workers using such tools. The heads of hammers and similar tools must be kept tight on their handles.

If the head of a tool becomes mushroomed, it may chip during use, and the flying chip may penetrate an eye or may cause other serious injury. Mushroomed tool heads should be reground. Overhardened tools present the same hazard—they are brittle and tend to chip or break in use.

Any tool not in use should be returned to the toolbox or put aside in a safe place. Tools carelessly left lying about in work areas are common causes of industrial accidents.

*Be sure ladders are safe.* Ladders that are weak or broken or that have missing rungs must not be used. Wooden ladders should never be painted; the paint hides the grain and conceals potentially dangerous splits in the wood. No ladder should ever be overloaded. Ladders other than stepladders must be secured against slipping. This may be done by nailing a cleat on the floor in front of the ladder; by fastening the feet of the ladder securely to the floor; by installing safety shoes on the ladder; or by lashing or fastening the ladder at its top. When in use, ladders should extend at least 3 feet (0.9 metre) above the roof's eave and be tied off to the building.

Some additional precautions to take when using a ladder include the following:

1. Use a ladder with safety feet suitable for the surface it stands on.
2. If the surface is extra slippery, tie the ladder at the base or have someone hold it.
3. If the ladder is placed before a doorway, lock the door, or have someone guard it. Protect the ladder's base from traffic, if necessary.
4. When using a stepladder, make sure it is fully extended before you climb.
5. If your shoes are muddy or otherwise slippery, clean them before you climb.
6. Be sure the ladder is placed at a safe angle against the wall or other solid backing. An angle of about 75 degrees with the horizontal is recommended.
7. Always face the ladder and hold on with both hands, whether climbing up or down.
8. Carry tools in suitable pockets; or have tools and all other objects hoisted.

*Wear clothing appropriate for the job.* It is the responsibility of the worker to choose clothing appropriate for his or her work. Protective clothing is required for on-the-job safety, and workers must use the safety equipment provided. Garments with loose sleeves, tails, frills, lapels, or cuffs are very dangerous. Clothing that has become saturated with flammable liquids, corrosive substances, irritants, or oxidizing agents, or that has been exposed to radioactive materials, is not safe to wear until it has been properly cleaned.

Shoes that have thick soles and good heels reduce the possibility of injury from stumbling or slipping or from sharp objects that might puncture the foot. The worker should wear protective shoes when feet may be endangered by falling objects; by hot, corrosive, or poisonous substances; or by the hazards that accompany work in unusually wet locations. Safety shoes having steel-clad toes are often used.

In those areas where flying particles, hazardous substances, or harmful light rays present a hazard to their eyes, workers must wear goggles, spectacles, or face shields of the correct type for their protection. In operations that present eye hazards, nearby workers, as well as the worker performing the operation, must be protected. Suitable screens or shields must be used to isolate the hazardous exposure when practicable. Goggles used for eye protection must have lenses dark enough to screen out injurious ultraviolet and infrared rays and glare. Approved hard hats must be worn in designated areas.

A properly attired roofer is shown in Fig. 5-2.

*Know and respect the hazards of electrical shock.* Electrical shock results when all or part of the body becomes part of a live electrical circuit. A shock can occur only if the electrical current finds a path through the body, entering at one point and leaving at another. The intensity of the shock depends on how much current passes through the body, which in turn depends on two factors: (1) the voltage (electrical pressure) impressed across the body; and (2) the electrical resistance of the body at the moment of the shock.

All electrical service wiring incorporates one or more live or "hot" conductors and a neutral or "return" conductor. The neutral conductor is connected to earth ground. Shock will result if the worker does any of these things: (1) simultaneously comes in contact with a live conductor and grounded object or surface, such as

a utility pipe, a damp floor, or the earth itself; (2) simultaneously touches a live and a neutral conductor, for instance by grasping both exposed conductors of a badly frayed power cord; or (3) while in contact with the ground or a grounded object, touches a metallic object that has itself become "hot" through contact with a live conductor.

The first duty of a person reaching a victim of electrical shock is to remove him or her from contact with the energized wire or equipment, being careful not to contact either the victim or the energized object. The power must quickly be turned off if the switch is nearby, but no time should be lost in looking for the switch. A stick, board, rope, article of clothing, or other nonconducting object can be used to free the victim from the wire, but the thing used must be dry; and the rescuer must be standing on a dry, nonconducting surface. Standard resuscitation procedure should be started immediately after an unconscious victim of electrical shock has been freed, and a doctor should be called as soon as possible. Resuscitation should be continued until the victim is breathing normally or until a competent medical authority gives the rescue worker other instructions.

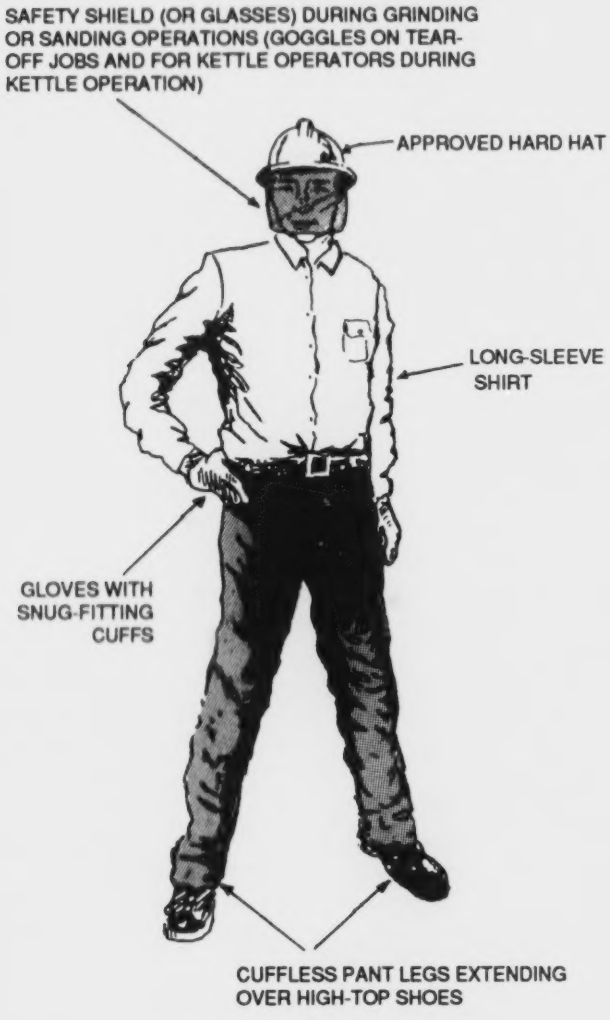

SAFETY SHIELD (OR GLASSES) DURING GRINDING OR SANDING OPERATIONS (GOGGLES ON TEAR-OFF JOBS AND FOR KETTLE OPERATORS DURING KETTLE OPERATION)
APPROVED HARD HAT
LONG-SLEEVE SHIRT
GLOVES WITH SNUG-FITTING CUFFS
CUFFLESS PANT LEGS EXTENDING OVER HIGH-TOP SHOES

**Fig. 5-2. Properly attired roofer**

The insulation on conductors must be in good condition, and all non–current-carrying metal parts of electrical tools and power machines must be grounded. If these conditions prevail and if the following commonsensical rules are observed, the danger of electrical shock can be held to a minimum:

1. Consider all electrical wires live unless they are known to be otherwise.
2. Do not work with electrical circuits unless you are qualified and authorized to do so.
3. Do not make repairs to electrical equipment unless you are qualified and authorized to do so.
4. Double-check to ensure that main switches are off before touching electrical conductors or other potentially "hot" electrical components. Lock the switch box, and place a warning sign on it to ensure that another person does not turn on the main switches.

### Specific Safety Rules for Roofers

Listed below are some essential safety practices specific to the roofing and waterproofing trade.

*Prevention of slips and falls.* To help prevent slips and falls, workers should do the following:

1. Inspect roofs for sufficient structural strength to hold necessary personnel and materials. Canopies and cornices, especially in old buildings, are often weakened by years of weathering. Even new buildings sometimes have defective roof sheathing that may fail under the weight of workers carrying heavy asphalt or pitch buckets.
2. Make sure that all precautions have been taken to prevent workers from falling off roofs.
3. Eliminate hazards that could cause a worker to trip. Pile materials away from roofs' edges and other danger points.
4. Be sure that skylights and other openings are guarded by strong coverings or railings. Ensure that such openings are not hidden.

5. Wear proper shoes. Loose shoes and shoes with worn heels or slippery soles invite slipping. Shoes should have high tops—at least to ankle height.
6. Clean up spilled asphalt or pitch at once.
7. Wear pants that have legs extending over the tops of shoes. Pant legs should not have cuffs.

*Burn prevention.* Burns are a common occupational hazard in the roofing and waterproofing trade. To aid in the prevention of burns, roofers and waterproofers should observe the following practices:

1. Handle "hotstuff" (heated asphalt or coal-tar pitch) only if properly trained to do so.
2. Do not stand too close to a kettle that is in operation or that is still hot from operation.
3. Turn on the kettle's tap slowly to prevent splattering.
4. Do not draw off bitumen too fast. Feed additional pieces of cold bitumen (coal-tar pitch or asphalt) into the heated kettle without causing the heated contents of the kettle to splatter.
5. Be sure that buckets containing hotstuff are filled no higher than 4 inches (10.2 centimetres) from the top.
6. Do not carry more than one bucket of hotstuff at a time on roofs of one-fourth pitch and greater.
7. When carrying a bucket of hotstuff, hold it slightly away from the body, and avoid swinging it.
8. In pouring hotstuff from one bucket to another, pour slowly and evenly to avoid splashing.
9. Wear gloves and a shirt with full-length sleeves fastened at the wrist when carrying hotstuff or working near it. Gloves worn by roofers should have snug-fitting cuffs.
10. Be sure that hot kettles are attended at all times. A full fire extinguisher should be available at the kettle and on the roof whenever burners are operating.
11. Place carts, buckets, and highboys of hotstuff convenient to the mop person but never where he or she may fall over them while mopping.
12. When filling a bucket from a highboy or other device that has a spigot, keep one hand on or near the spigot at all times so that it may be turned off immediately in case of a flash fire. A handle extension may be used as a further safety measure.
13. Use a hoist or pumping equipment to deliver hotstuff to roofs; Section 1725 of the *Construction Safety Orders* specifically prohibits the carrying of hotstuff up ladders. Be sure that the pathway from the kettle to the hoist is clear.
14. When taking a bucket of hotstuff off a hoist, use one hand to brace yourself and with the other hand carefully guide the bucket to a safe landing on the roof, avoiding any swing that might cause splashing. Place the bucket to either side, never directly behind you.
15. Never walk on a sheet of roofing that has just been laid. The hot asphalt or pitch under it may still be in a molten state, allowing the sheet to slip and causing you to fall.
16. Vapors from roofing pitch (coal-tar pitch) can cause severe irritation to the skin. If you are working in the immediate vicinity of coal-tar pitch, protect your face with frequent applications of a lanolin-base cream. Always wear a long-sleeve shirt to protect your arms from the vapors.
17. To the degree possible, avoid breathing coal-tar pitch vapors. If you work in confined spaces where hazardous vapors may become concentrated, you should protect exposed skin surfaces with even greater thoroughness. If possible, always use a portable ventilation fan to remove the vapors.
18. Thoroughly wash all exposed skin areas after exposure to coal-tar products. The harm resulting from such exposure depends on the amount of exposure to the pitch vapors and the skin pigmentation of the individual. For example, a person with fair complexion will suffer more severe burns than one with a dark complexion. Remember that these vapors are also given off by the dust that is present during the tear-off of a pitch roof.
19. If a kettle is heated above the flash point, a flash fire can occur at the spigot when hotstuff is poured into a bucket. In such a case, shut off the spigot and place a piece of felt over the bucket to extinguish (smother) the fire. If a flash fire occurs at the rooftop while a highboy is being filled, release the flow of hotstuff, back the highboy up, and shut the lid. If a flash fire occurs in a bucket of hotstuff you are carrying on a roof, set the bucket down slowly, and place a piece of felt over it until the fire is extinguished. Never drop or throw a bucket of burning hotstuff; doing so could set the entire roof on fire.

*Prevention of eye injuries.* Kettle operators operating kettles and roofers working on tear-off jobs must wear safety goggles.

### Other Safety Precautions

The safety information presented thus far by no means exhausts the subject. Early in the training period, the trainee must learn the safety regulations that apply to his or her trade. Trainees in the roofing field must become familiar with the state's *Construction Safety Orders* handbook, and they should know the "Safe Practices and Operations Code" included in Appendix A of the handbook.

The following are some special precautions that need emphasis for construction workers:

1. Usually, a number of locations on a construction site are guarded or barricaded. Do not remove the guards without good reason. Do not take shortcuts; the barricades and walkways are put there for your safety.
2. Take all possible precautions to prevent fires. Dispose of matches and cigarette butts in a safe manner. Potential fire hazards include oil-soaked timber or rags; hot mops; flammable gases; flammable shop materials improperly stored; accumulations of rubbish; overheated machines; overloaded electrical circuits; and electrical wire with inadequate insulation.
3. Keep off all equipment such as cranes, pile drivers, and trucks unless it is part of your job to be there. Do not walk alongside or behind a moving truck, and watch for trucks moving in your path. Do not stand under loads on cranes. Never take hold of a rope or cable near the top blocks or sheaves; your fingers could be drawn into the blocks.
4. Machines with dangerous moving parts are equipped with safety guards. Make sure the guards are in place when the machine is running.
5. Do not handle or tamper with electrical equipment, machinery, or air or water lines if you are not qualified and authorized to work on them. Do not operate any power tool or other machine unless you have been instructed in its use and are certain you know how to use it. Do not close switches, turn on compressed air or water, or set in motion any machine until you are certain that no person is in a position to be injured by your act.
6. Do not clean, oil, or repair any machine while it is in operation. If you must adjust or repair a power machine, shut off the main power switch serving it, lock the switch, and attach a warning note to the switch box to ensure that the power will not be turned on unexpectedly during the repairs.
7. Whenever you leave your power machine for any purpose, shut it off unless another qualified operator stands by and assumes responsibility for its safe running while you are gone.
8. Remember that while some toxic gases have an odor that establishes their presence, others—like carbon monoxide—are odorless. When you must work in a confined space where toxic gases are present or could be present, ensure that the area is well ventilated and that it will remain ventilated throughout the work period. In addition to carbon monoxide, common toxic gases include the fumes of carbon tetrachloride, gasoline, paint, and turpentine.
9. Wash thoroughly any parts of your body that may have been contaminated as a result of your handling poisonous or other injurious substances. Do not handle food until this has been done. Follow all special instructions from authorized sources when handling, using, or storing toxic chemicals. Do not use gasoline for cleaning.
10. When you discover an unsafe condition on the job, report it immediately to the proper authority.
11. Never indulge in horseplay or scuffling on the job.

## When an Accident Occurs

When an accident occurs, report any injury sustained, no matter how slight. Small cuts or abrasions may seem of little consequence, but if they become infected, they can be as serious as a major injury. Take time to disinfect a cut as soon as it occurs. If a fellow worker suffers injury in an accident, give first aid as required and call a doctor or get other competent medical assistance. If an accident results from a hazardous condition that is correctable, see that the condition is brought to the attention of the supervisor and corrected.

### General First-aid Measures

Some general directions for administering first aid are provided below.

- Keep the injured person lying down.
- Do not give liquids to an unconscious victim.
- Control bleeding by pressing on the wound.
- Use mouth-to-mouth artificial respiration to restore breathing.
- Give poisoning victims substantial quantities of water to dilute the poison.
- Keep broken bones from moving.

- Immerse burns in cold water or apply ice directly to the burned area.
- Keep heart attack victims quiet.
- For someone who has fainted, keep the head lower than the heart.
- Cover eye injuries with gauze pads.

#### First-aid Measures for Unconscious Persons

The following emergency measures should be followed in administering aid to someone who is unconscious:

- Place the victim flat on his or her back on a hard surface.
- If the victim is unconscious, open his or her airway by lifting with one hand underneath the neck and pushing the forehead back with the other hand. If necessary, clear obstructions from the mouth. If the victim begins breathing, keep his or her airway open until medical help arrives.
- If the victim is not breathing, begin artificial breathing. Keep the victim's head tilted back, and pinch his or her nose to keep air from escaping. Give the victim four quick, full breaths, and then locate the victim's carotid pulse to determine whether the heart is beating.
- To find the carotid artery, locate the victim's voice box by sliding the tips of your index finger and middle finger to the groove beside the voice box. Cardiac arrest can be recognized by absent breathing and an absent pulse in the carotid artery.
- If no pulse is present, provide artificial circulation by means of cardiac compression. Kneel at the victim's side near his or her chest. Locate the notch at the lowest part of the sternum. Place the heel of one hand on the sternum, 1 1/2 to 2 inches (3.8 to 5.1 centimetres) above the notch. Place your other hand on the top of the one already in place. Keep your fingers off the chest wall; interlocking your fingers can be helpful in avoiding such finger placement. Place your shoulders directly over the victim's sternum, and compress downward. Keep your arms straight during the compression. Compress the sternum about 1 1/2 to 2 inches (3.8 to 5.1 centimetres) for an adult victim. Relax the pressure, but do not remove your hands from the victim's sternum. Allow the victim's chest to return to its normal position between compressions.
- If you are the only rescuer, apply 15 chest compressions and then two quick breaths at the rate of 80 times per minute. If two persons are working on the victim, they should place themselves on opposite sides of the victim, with one compressing the sternum and the other giving the breaths of air to the victim. In this case give five compressions followed by one quick breath 60 times per minute. Continue the procedure until medical aid arrives.

*NOTE:* It is recommended that, whenever possible, only personnel trained and certified in cardiopulmonary resuscitation provide the care described above. Training and certification are available from several organizations, including the Red Cross and American Heart Association. A person who further injures a victim to whom he or she is giving aid may be held responsible for his or her actions.

#### Care for Victims of Sunstroke, Heat Exhaustion, and Heat Sickness

Sunstroke is indicated by skin that is dry and hot. Keep the victim cool, and call a doctor.

If a person is suffering from heat exhaustion, his or her skin will be damp and cold. Treat heat exhaustion as you would shock; that is, keep the victim warm and covered with blankets or other covering. If the victim is conscious, give him or her stimulants, such as hot coffee. Never give an unconscious person anything to drink.

Heat sickness is caused by excessive loss of salt from the body through excessive perspiration. Unless the body salt is maintained or replaced (through salt tablets or normal diet), muscular efficiency is lowered, and painful muscular contractions and cramps may result. Move the victim to the nearest shade, apply cold water or ice packs, and seek medical attention.

## Study Assignments

1. *CALIOSHA, State of California Construction Safety Orders* (Current edition). Los Angeles: Building News, Inc. Read Article 30, "Roofing Operations and Equipment."
2. Review warning labels on containers and consult the OSHA Material Safety Data Sheet for the product if you are unsure about the safe procedures for handling, applying, and storing it.

TOPIC 6

# Types, Styles, and Structural Designs of Roofs

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **List and describe the common types of roofs.**
- **Identify the basic parts of each type of roof.**
- **Describe the primary differences between the roofs of residential buildings and those of commercial or industrial structures.**
- **Explain what is meant by the "pitch" of a roof.**
- **Determine the pitch of a roof.**

## Types of Roofs

Roofs can be constructed in a variety of styles. The roof of a structure may be of a single type of construction, or it may consist of a combination of styles. For residential structures the most common types of roofs are the shed, gable, hip, mansard, gambrel, and flat roofs (Fig. 6-1). Flat roofs, barrel roofs, and sawtooth roofs (Fig. 6-2) are the types most commonly used for commercial and industrial buildings.

The type of roof to be used on a given structure depends on several factors, including the overall architectural style of the building, climatic conditions, the maximum weight and stress that the roof will have to withstand, and the personal preferences of the architect, builder, or owner. The "dead" load of a roof refers to the weight of the roof, which includes the framing members and roof covering. The "live" load of a roof includes the weight of the workers and materials to be supported by the roof during construction and repairs. Roofs in areas that receive significant amounts of snow must be designed to bear the additional weight created by snow accumulation and are generally built with a steeper pitch (slope) than are those in areas where snow is not a problem. Strong winds also exert a great deal of pressure on a sloping roof. A steeply pitched roof presents more surface to the wind and is subject to greater stress from this source.

In residential buildings rafters or beams are used as the chief means of support for the roof (Figs. 6-3 and 6-4). In very large buildings, however, stronger support must be used. For these, specially engineered and constructed steel web beams, laminated wood beams, or trusses have been developed.

Detailed drawings of gable roof overhangs are provided in Figs. 6-5 through 6-7.

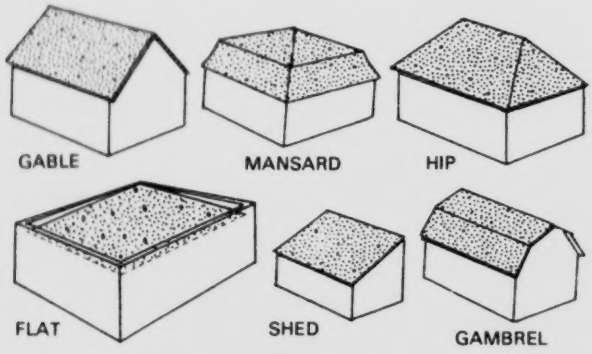



**Fig. 6-1. Basic types of roofs used for residential structures**

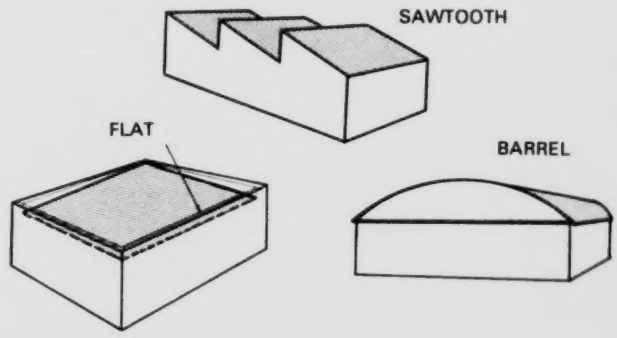



**Fig. 6-2. Basic types of roofs used for commercial and industrial structures**

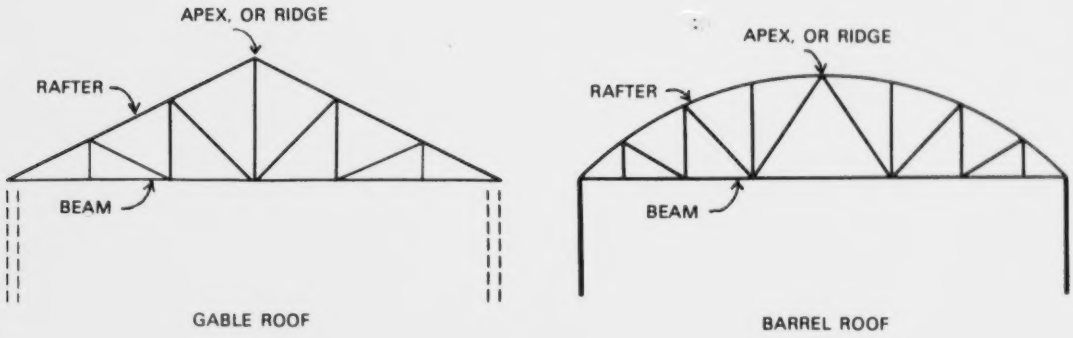



**Fig. 6-3. Howe truss (left) and bolstering truss (right)**

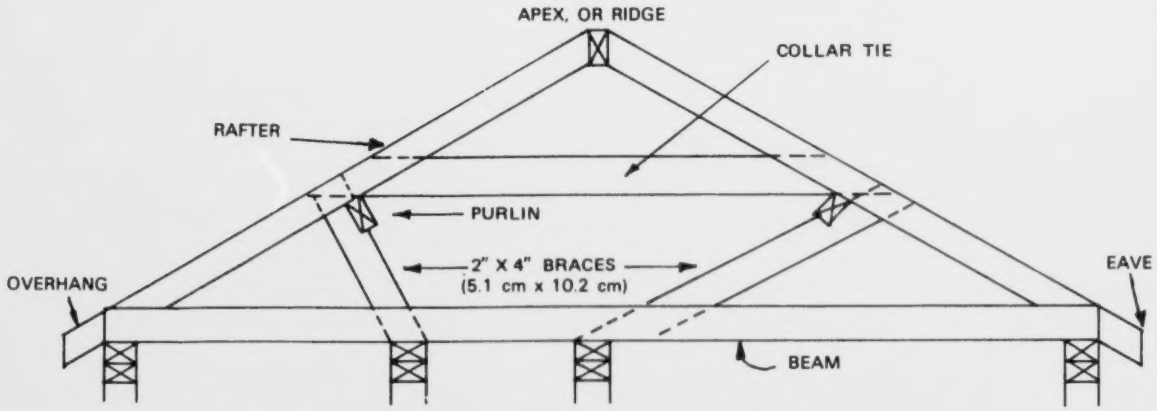



**Fig. 6-4. Gable roof frame with purlins and braces**

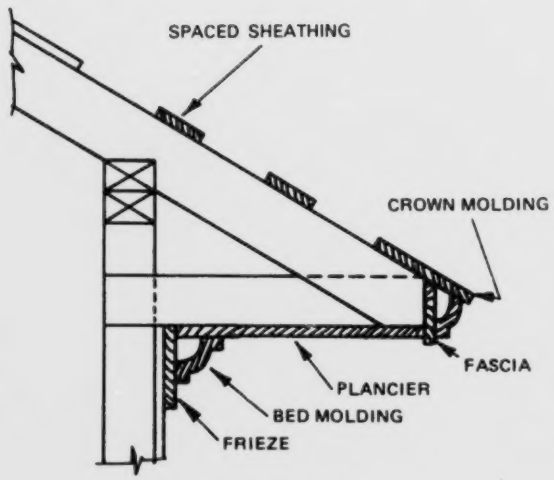



**Fig. 6-5. Closed cornice**

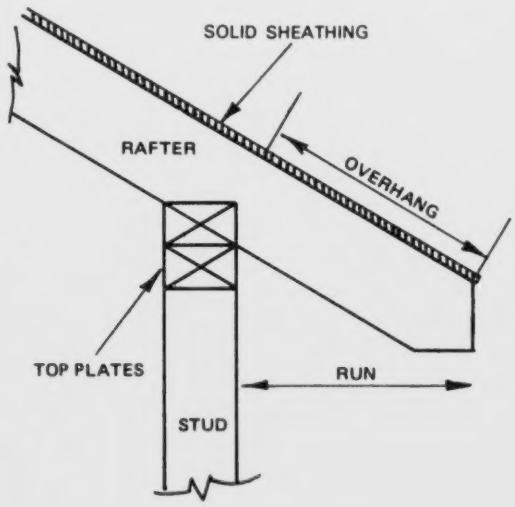



**Fig. 6-6. Open cornice**

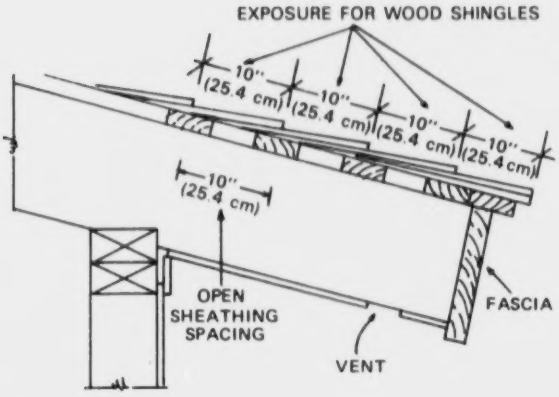



**Fig. 6-7. Spaced roof sheathing**

Although constructing roofs supports is not part of the roofer's trade, every roofer should be familiar with such construction. The points at which the roof deck comes in contact with these supports are the strongest points of the deck and, thus, are the places where materials and equipment can be safely loaded and where workers can walk safely.

Another important factor in determining the load that can safely be placed on a roof is the material used to construct the roof deck. The deck may be made from any of several materials, only some of which are strong enough to hold considerable loads safely. Decks that are particularly strong are those made of prestressed concrete, monolithic concrete (thick slabs), and metal.

Other materials used to construct decks include gypsum, thin-shelled concrete, plywood, and fiberboard. Decks constructed of these materials are not as strong as those made of the materials listed above, and the roofer must therefore take care to place materials and equipment only over the beams and trusses of such decks. Dropping materials on these types of decks should also be avoided.

## Roofs over Residential Structures

As was mentioned previously, shed, gable, hip, mansard, gambrel, and flat roofs are the types most commonly used for residential structures. With the exception of flat roofs, these roof types and dormers are discussed below. Flat roofs are discussed in the section on roofs for commercial and industrial structures.

### Shed Roof

The shed roof (Fig. 6-8), which is also called a lean-to roof, slopes in only one direction and is less expensive to construct than roofs that slope in more than one direction. It is generally used for porches, but it is also used occasionally for houses. In many cases the underside of a shed roof also serves as the ceiling of the house. For this reason, care must be taken to ensure that nails driven into the roof deck are not so long that they will show on the underside of the deck.

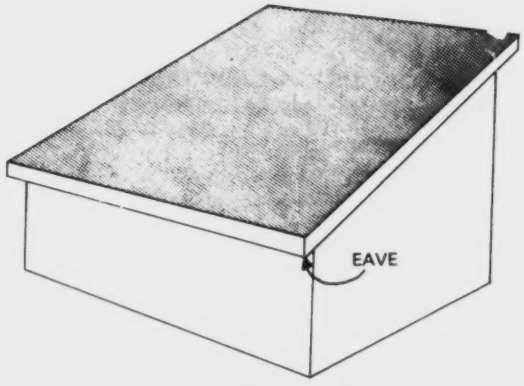



**Fig. 6-8. Shed roof, or lean-to roof**

### Gable Roof

A gable roof (Fig. 6-9) slopes in two directions. The strongest point of a gable roof is the ridge; and, like all roofs, the weakest part is the eaves. The eaves are especially weak if a fascia, or board, is not nailed across the ends of the rafters.

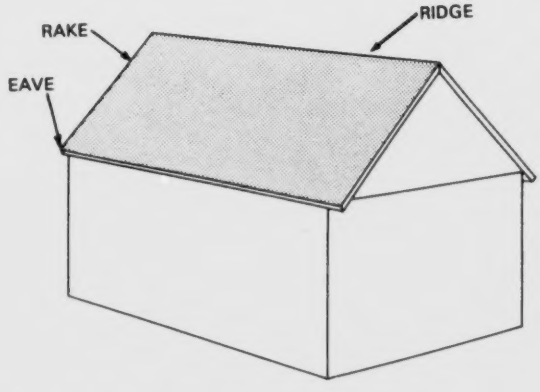



**Fig. 6-9. Parts of a gable roof**

### Hip Roof

A hip roof (Fig. 6-10) slopes in four directions and is more difficult, more costly, and more time consuming to build than a gable roof. The ridges and hips are self-supporting, but the valley rafters, if any, generally require support from below. Such support is not possible, however, if the valley is placed over a large room. Heavy loads should not be placed over valleys.

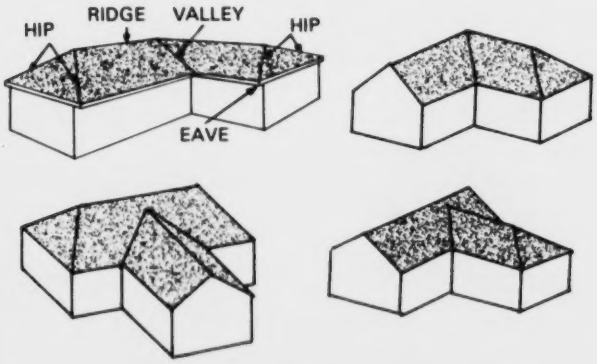



**Fig. 6-10. Hip roof and variations of hip and gable intersecting roofs**

### Mansard Roof

Like the hip roof, the mansard roof (Fig. 6-11) slopes in four directions. The mansard roof is generally constructed with a parapet (a low wall above the roof level). The deck of such a roof is normally flat.

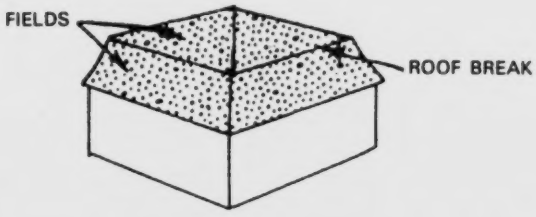



**Fig. 6-11. Parts of a mansard roof**

### Gambrel Roof

The gambrel roof (Fig. 6-12) slopes in two directions, but each slope is broken in the middle to provide more living space under the roof. This type of roof was developed in the United States in colonial times so that the home owner could avoid the payment of a tax imposed on two-story houses.

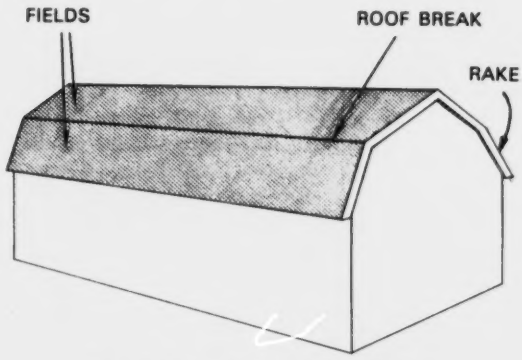



**Fig. 6-12. Parts of a gambrel roof**

### Dormer

Dormers (Fig. 6-13) are roofed structures that contain windows and that are set vertically in a sloping roof. A valley is formed at the point where a dormer and the roof join. Dormers are roofed at the same time as the rest of the roof.

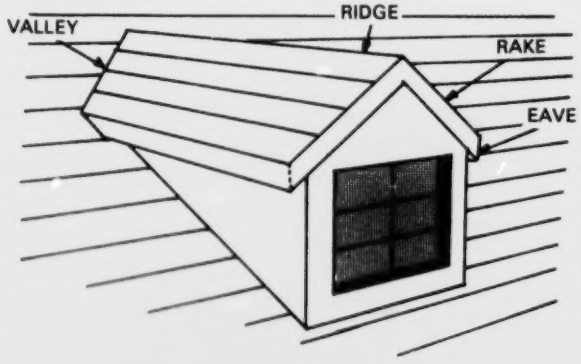



**Fig. 6-13. Parts of a dormer**

## Roofs over Commercial and Industrial Structures

Various types of roofs used on commercial and industrial structures are discussed in the following sections.

### Flat Roof

Roof structures over commercial and industrial buildings must be of stronger construction than those over residential buildings. This is because they (1) usually cover wider spans; and (2) often serve as support for machinery and other heavy equipment. As was pointed out earlier, this added strength has been provided in a number of different ways, such as by steel beams, laminated wood beams, or trusses.

In many cases the roof deck laid over these supports is flat or nearly flat (Figs. 6-14 through 6-17). Generally, provision must be made for draining water from these wide expanses. For this reason, the roof may be sloped slightly toward the center, sides, or corners where drains are located.

Commercial or industrial buildings in many cities are required by fire laws to be separated from other buildings by walls that extend some distance above the roof. These are called parapet walls. In addition, to prevent the spread of fire from one part of a building to another, fire walls are constructed from side to side within the building. These, too, extend above the roof deck.

Weight distribution is of prime importance when a flat roof is loaded. Insofar as possible, loads should be placed over the trusses or beams.

The extensive use of flat roofs on residences is a comparatively new practice, having been made possible through the development of asphalt to provide a watertight seal. The definition of a "flat" roof varies, but it is usually considered to be any roof surface with a slope of less than 1 1/2 inches in every 12 inches (3.8 centimetres in every 30.5 centimetres) of vertical rise (sometimes written as 1 1/2/12).

### Barrel Roof

Because built-up roofing (roofing formed by a number of layers of roofing mopped together with hot asphalt or pitch) is the primary type of covering used on commercial and industrial structures, the slope cannot be too great. However, to take advantage of some of the truss shapes and to aid in drainage, commercial build-

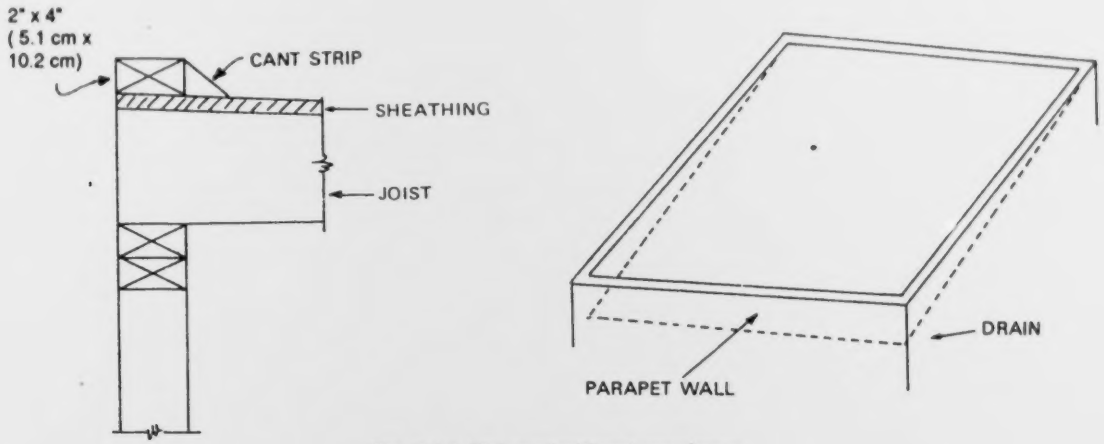



**Fig. 6-14. Flat roof without overhang**

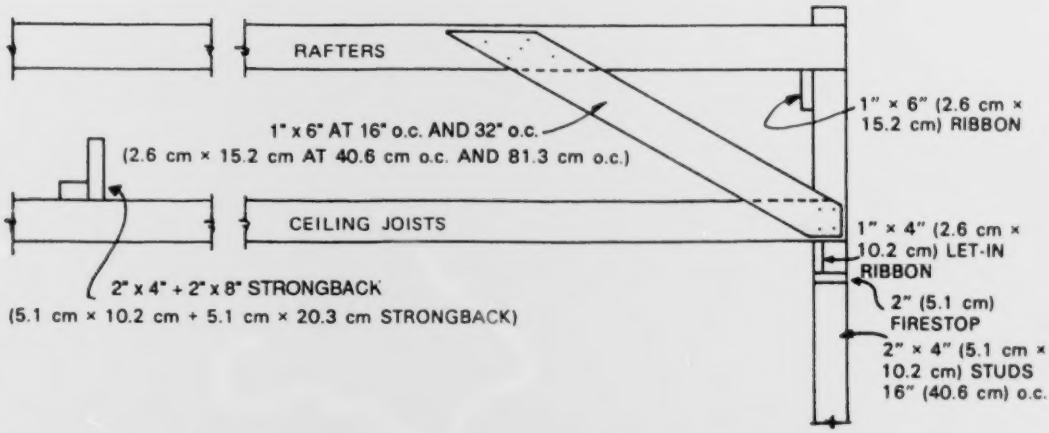

RAFTERS
1" x 6" AT 16" o.c. AND 32" o.c.
(2.6 cm × 15.2 cm AT 40.6 cm o.c. AND 81.3 cm o.c.)
CEILING JOISTS
2" x 4" + 2" x 8" STRONGBACK
(5.1 cm × 10.2 cm + 5.1 cm × 20.3 cm STRONGBACK)
1" × 6" (2.6 cm ×
15.2 cm) RIBBON
1" × 4" (2.6 cm ×
10.2 cm) LET-IN
RIBBON
2" (5.1 cm)
FIRESTOP
2" × 4" (5.1 cm ×
10.2 cm) STUDS
16" (40.6 cm) o.c.

**Fig. 6-15. Insulation provided by open space between joists and rafters of a flat roof**

ings often have a pitch great enough to be considered other than flat. The barrel roof (Fig. 6-18) is an example of one of these types.

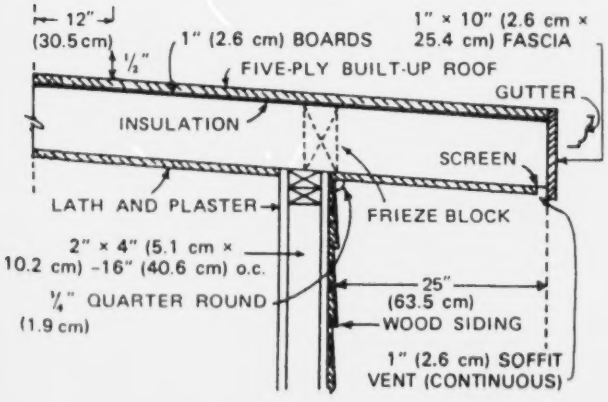



**Fig. 6-16. Parts of a typical flat roof with overhang**

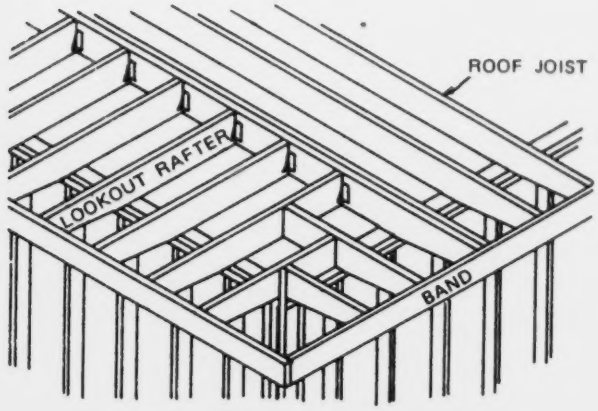



**Fig. 6-17. Typical procedure for framing the overhang of a flat roof**

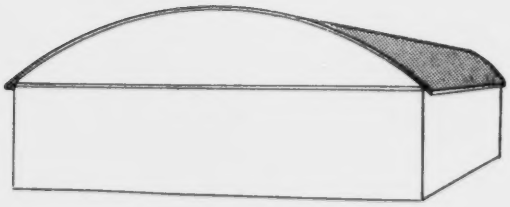


**Fig. 6-18. Barrel roof**

### Sawtooth Roof

The sawtooth roof (Fig. 6-19) is used over industrial buildings to admit light from above. Windows are placed in the vertical part of the roof projection.

Essentially, each sawtooth is a shed roof and is treated as such. When roll roofing is used, it is often applied vertically because of the roof's pitch. Drainage is provided through washbacks in both directions.

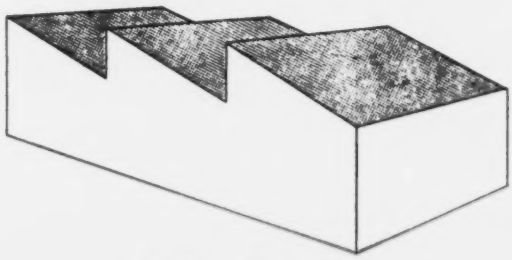


**Fig. 6-19. Sawtooth roof**

### Other Roofs

On occasion, the roofer will encounter more unusual roof shapes, such as the vaulted, serpentine, geodesic, conical, pyramid, and domed roofs (Fig. 6-20). The use of epoxies is generally required for these

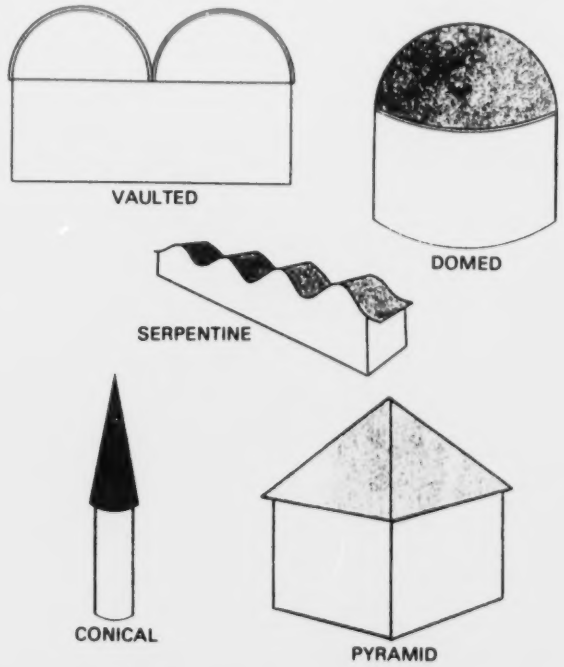



**Fig. 6-20. Other types of roofs used on commercial and industrial structures**

roofs because the shapes are such that built-up roofing materials cannot be applied to conform to the shape of the structure.

The church steeple is a good example of a conical roof. Composition shingles, slate, or tile are the most practical roof coverings. In many cases these and related roof types cannot be worked on except from a scaffold.

## Gable Roof Terminology

A structural view of the gable end of a roof is shown in Fig. 6-21. Two right triangles (triangles that include a 90-degree angle, or right angle) are apparent.

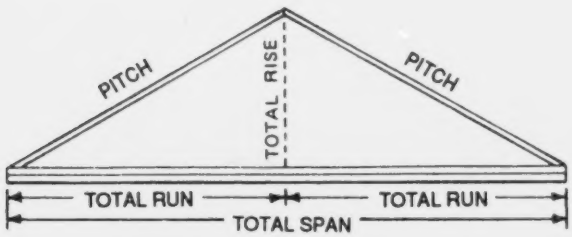



**Fig. 6-21. Parts of the gable end**

### Total Span

The total span of a roof is the overall width of the house. This dimension can be found in the floor or roof plan sections of the blueprints.

### Total Run

The total run of a roof is always one-half of the total span.

### Total Rise

Total rise is the vertical distance from the top of the plate line to the top of the ridge.

### Pitch

The pitch of a roof determines the angle or the amount of slope for a particular roof. Pitch is based on the ratio of the total rise to the total span.

For example, a roof with a total rise of 7 feet (2.1 metres) and a total span of 28 feet (8.5 metres) has a 1/4 pitch (7/28 = 1/4) (6 inches in 12 inches or 6/12).

The pitch of the roof usually is not indicated on the plans. A small triangle is drawn to show the unit of rise and the unit of run. (See Fig. 6-22.)

The unit of rise is the number of inches that a common rafter will rise vertically for every 12 inches (30.5 centimetres) that it advances horizontally (Fig. 6-23). The unit of rise of a roof can be as much as 24 inches (70 centimetres).

Obviously, a roof with a 4-inch (10.2-centimetre) unit of rise will have far less slope than a roof with a 24-inch (70-centimetre) unit of rise. The unit of run will be expressed as 12 inches or 1 foot (30.5 centimetres).

Because the unit of rise is the vertical height of a common rafter in 1 foot of run, the number of feet in

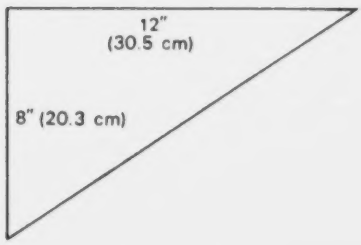



**Fig. 6-22. Plan symbol showing unit run and rise**

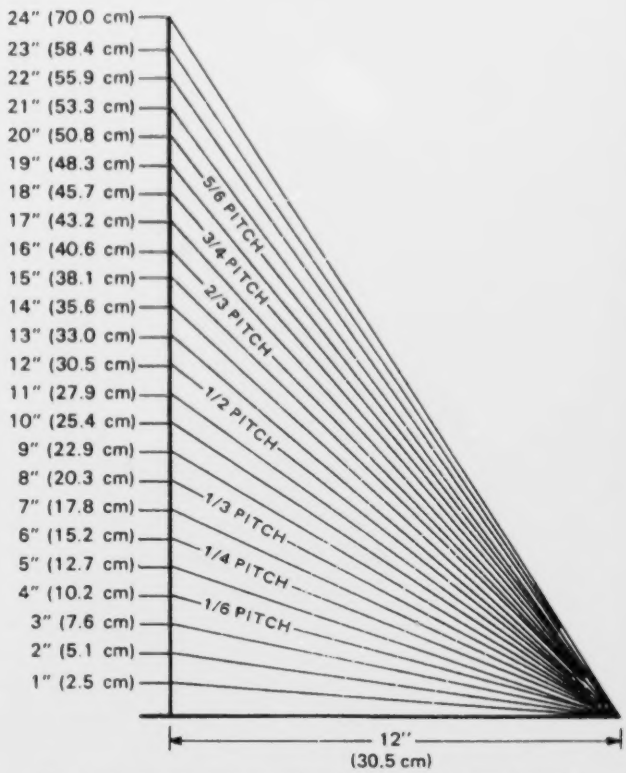



**Fig. 6-23. Commonly used unit rises for sloped roofs**

the total run times the unit of rise will give the total rise of the roof. For example, the plans show that the roof has a span of 16 feet (4.9 metres) and a unit of rise of 10 inches (25.4 centimetres). Half of the total span would give a total run of 8 feet (2.4 metres or 243.8 centimetres). The total rise would be 80 inches or 6 feet 8 inches (203.2 centimetres or 2.03 metres) (8 x 10 inches = 80 inches or 6 feet 8 inches; 8 x 25.4 centimetres = 203.2 centimetres or 2.03 metres).

## Study Assignment

***Uniform Building Code*** **(Current edition). Whittier, Calif.: International Conference of Building Officials. Read and study all applicable sections.**

TOPIC 7

# Hand Tools and Power Tools

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Identify the basic hand tools used by roofers.**
- **Demonstrate the safe use of the basic hand tools.**
- **Identify the power tools commonly used by roofers.**
- **Demonstrate the safe use of power tools.**

THE tools that a worker owns and uses in his or her trade tell a good deal about his or her attitude toward the trade and the quality of work produced. If the tools are the correct ones for the job, of good quality, and well cared for, the worker is probably one who takes pride in a job well done. If, on the other hand, his or her tools are the wrong tools, of poor quality, or poorly cared for, the worker is probably one who merely does a job; that is, one who does not make a positive contribution to the trade. The apprentice should, therefore, begin to acquire the tools that he or she will need and take proper care of them.

The apprentice should become familiar with every tool that he or she might be called on to use in the trade. Some tools must be furnished by the employer; the responsibility for supplying other tools rests with the worker. The tools illustrated or described in this topic are those that roofers and waterproofers in California must generally supply themselves.

## Basic Hand Tools

The basic hand tools needed by a roofer and waterproofer are shown in Fig. 7-1. The apprentice should purchase additional tools as the need for them arises. Other tools that the roofer and waterproofer may need include side-cutting pliers, tile nippers, flat trowel, open-end wrench, handsaws, cold chisel, whisk broom, allen wrench, Phillips screwdriver, stapling hammer, and caulking gun.

## Basic Power Tools

The roofer and waterproofer may also use a variety of power tools. Those most commonly used are the following:

1. Portable electric saw—Portable electric saws are often used for cutting reglets (beveled nailing strips for flashing set into the masonry wall in concrete construction). A carborundum blade is used in such cases.
2. Pneumatic nailer.
3. Tile saw—The operator of a tile saw should always wear goggles or a face shield, a dust respirator, and an approved hard hat.
4. Portable electric drill.

## Safety with Tools

Safety principles and practices were discussed extensively in Topic 5, "Safety in the Industry." The four rules listed below are presented for emphasis; they should be learned and practiced by every worker in the industry.

1. Use the right tool for the job. Never use a tool to do a job for which it was not made. Use the right tool, and be sure it is the right size for the job. Know the limitations of the tool—do not overload it.
2. Learn how to use tools correctly. If used incorrectly, even small tools can cause severe injuries. A tool must be used skillfully and in the way for which it was designed if it is to be safe. Every worker must develop safe work habits in the use of tools, both for his or her own protection and for the protection of others on the job.
3. Keep tools in the best condition possible. Keep tools clean, and keep metal parts free from rust. Keep cutting tools sharp. Do not use defective tools—repair or discard them when they become damaged or when parts wear or become loose.

4. Keep each tool in its place. Never carry sharp tools in your pocket, and never leave them where they could cause injury or be damaged. Sheath sharp-pointed tools. A good tool bag, made for the kinds and sizes of tools needed in your trade, is necessary equipment.

**Study Assignment**

**Read and/or review in trade journals and manufacturers' catalogs information on hand tools and power tools used in the roofing and waterproofing trade.**

**Fig. 7-1. Roofer's basic tool kit**



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TOPIC 8

# Equipment

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the basic types of equipment used to carry hotstuff.**
- **Identify the basic pieces of equipment used to apply hotstuff.**
- **Describe the correct procedures for carrying and applying hotstuff.**
- **Identify the precautions to be observed in using a ladder.**
- **Identify the roof pitch at which roofing brackets, or jacks, must be used.**
- **Describe the differences between hoists and conveyors, and describe the safety precautions to be taken in using both.**
- **Describe the various types of fire extinguishers and the method of operation of each.**

New equipment for use in applying roofs and new roofing materials is being introduced at a rapid pace. In most instances the use of these machines will result in reduced labor costs and, used in conjunction with the new roofing materials, will result in an improved product.

The journey-level roofer must, therefore, become familiar with new materials, techniques, and equipment and above all must know how to use them correctly. He or she can learn a great deal about items new to the trade by studying trade journals, manufacturers' catalogs, and specifications manuals.

## Equipment for Handling Hotstuff

As materials have changed, so have methods and equipment. Years ago, for example, wood was used to heat asphalt; later, fuel oil became the primary source of heat. Today, LP (liquified petroleum) gas is the main fuel used in most areas.

The methods of lifting hot asphalt to the roof have also changed. At one time the only method of hoisting was the rope and wheel. Today, hotstuff is often pumped from the kettle to the roof by means of a pump attached to the kettle. In those cases in which kettles are not large enough to meet the demand, tank trucks, or tankers, are used to supply hot asphalt directly to the roof.

### Buckets and Other Transporting Equipment

Many kinds of buckets are used in the roofing industry, but those listed here are the most common types. A general safety precaution for the use of any bucket is to be sure that it contains no moisture when hotstuff is poured into it; water or other liquid in the bucket can cause hot asphalt to boil over, which could cause burns. Only OSHA-approved buckets should be used to carry hotstuff. Buckets that are made from lighter gage metal and have lighter gage handles should not be used.

A pouring can (Fig. 8-1) is used for pouring bitumen on the surface of built-up roofs before graveling or similar operations.

*Courtesy Tarrant Manufacturing Co.*

**Fig. 8-1. Pouring can**

The roofer's bucket (Fig. 8-2) is made of 24-gage steel. Its round iron carrying handle rests off the top to engage a hoisting hook. In some cases this bucket is insulated to help hold the heat.

*Courtesy Tarrant Manufacturing Co.*

**Fig. 8-2. Roofer's bucket**

Hot asphalt can be poured more easily and safely into mop buckets (Fig. 8-3) when a handle is attached near the bottom of the roofer's bucket. For ease and safety when the bucket is carried, this handle should face away from the body.

*Courtesy Classby Manufacturing Co.*

**Fig. 8-3. Mop bucket**

Carts, highboys, and lowboys (Figs. 8-4 through 8-6) are other types of equipment used to transport hotstuff. Again, such equipment should not contain moisture when hotstuff is poured in.

The wheels of carts, highboys, and lowboys should be cleaned as often as required to ensure a clean and easy application of roofing material, particularly on cap sheet roofs.

### Mops

Mops are made with various size heads of fiberglass or cotton. Cotton mops hold larger quantities of asphalt than fiberglass mops of the same size, but fiberglass mops are more durable and easier to drain. Both aluminum and wood are used for the handles.

Roller mops (Fig. 8-7) are used for applying hot asphalt in the waterproofing of walls and the like. A similar roller with short strands is used for applying roof coatings. *NOTE:* After use, mops should be cleaned, fanned out, and placed where they will not become fire hazards through spontaneous combustion. *Never leave a mop on a roof overnight.*

Another piece of equipment commonly used in the trade is the bituminous squeegee (Fig. 8-8). It is generally used for spreading emulsions and waterproofing compounds and for coating the blocks in industrial plants.

## Felt Layers and Gravel Spreaders

Felt layers and gravel spreaders have been perfected to permit almost perfect application. Power-driven machines that apply flood coat and gravel in one operation are now available. Although this procedure can be used successfully on large jobs, hand operations are still required on many small jobs. Even on large jobs, applications around skylights, flashings, and parapet walls still require some hand operation.

The principal type of felt layer in use today is an aluminum layer (Fig. 8-9), which flows asphalt onto the deck as it lays the felt. The aluminum felt layer has many variations. With some the asphalt is applied by means of gates or valves.

Most layers are suitable only for working on level roofs or nearly level roofs.

Usually, a roofer must walk backward while operating a felt layer. He or she must exercise extreme care to avoid backing into skylights or off the roof. This type of accident occurs often, in spite of precautions. The *Construction Safety Orders* prohibit operation of a felt layer without approved barricades in place at roof openings and perimeters.

Some gravel spreaders (Fig. 8-10) are operated by hand—that is, they are pulled or pushed by one or two workers—and others are power driven. With all of them

Courtesy Cleasby Manufacturing Co.

Fig. 8-4. Dumping-type insulation and felt cart

Courtesy Cleasby Manufacturing Co.

Fig. 8-5. Mop cart with removable tray

Courtesy Cleasby Manufacturing Co.

Fig. 8-6. Asphalt highboy (or lowboy)

Courtesy American Associated Companies

Fig. 8-7. Roller mop



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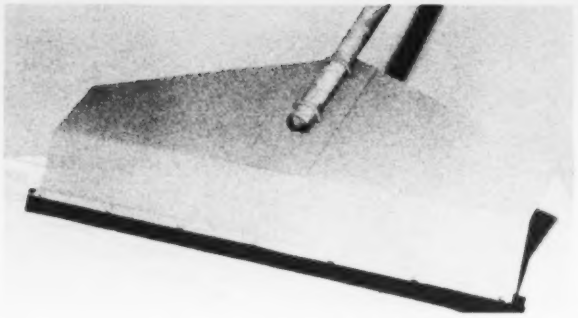
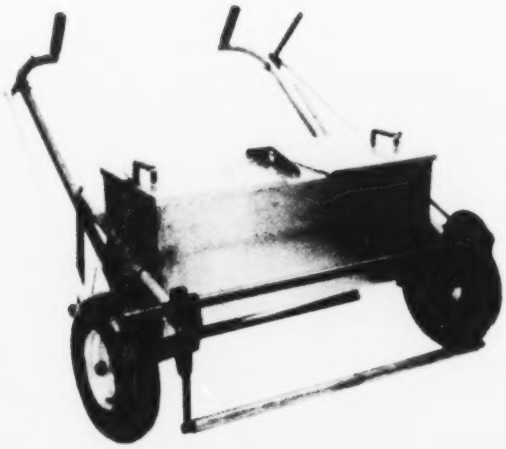


Courtesy Tarrant Manufacturing Co.

**Fig. 8-8. Bituminous squeegee**



Courtesy Cleasby Manufacturing Co.

**Fig. 8-9. Aluminum felt layer**

Courtesy Cleasby Manufacturing Co.

**Fig. 8-10. Gravel spreader**

the gravel flow can be adjusted in accordance with the requirements of the individual job.

The wheels of felt layers and gravel spreaders should be cleaned as often as necessary to ensure a clean and easy application of roofing material, particularly on cap sheet roofs.

## Equipment for Removing Gravel, Roofing, and Debris

A variety of equipment is used to remove gravel, roofing, and debris.

### Spudding Equipment

A spudding machine (Fig. 8-11) is used to loosen old roofing or gravel. Spudding machines can be operated in a relatively safe and efficient manner. In working with a spudding machine, the worker should observe the following practices:

1. Always obtain assistance when lifting the spudder.
2. Wear a respirator when dust is profuse.
3. Be sure V-belts, pulleys, sprockets, and chains are fully enclosed.
4. Provide adequate protection against rotating spudders.

Spudding bars (Fig. 8-12) are manually operated tools for loosening old roofing and gravel. They are made with steel handles and heavy blades. The worker should always wear gloves when using a spudding bar.

### Spades

Spades are used primarily for light spud-off. As with spudding bars, the worker should wear gloves when using a spade.

### Scoop Shovel

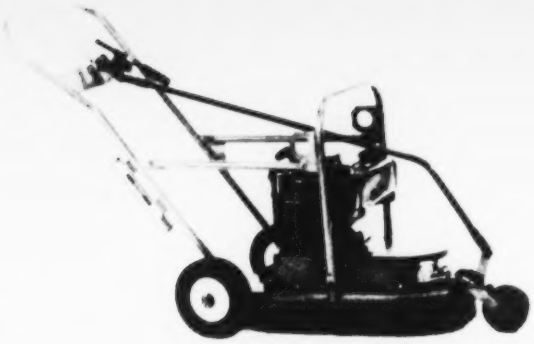
The scoop shovel (Fig. 8-13) is another tool used in spudding operations. It can be used for removing old roofing and gravel after spudding, for loading debris, and for hand graveling.

### Brooms

Both push brooms and upright brooms are used in the roofing and waterproofing trade (Fig. 8-14). A stiff-bristled broom is used to clean heavy dirt from walls and roofs, and a soft-bristled broom is used mainly to apply roll roofing.

### Wheelbarrows

The wheelbarrow is useful for general cleanup work and for the moving of gravel.



Courtesy Cleasby Manufacturing Co.

**Fig. 8-11. Rotary spudding machine**

## Spray Equipment and Brushes

Air compressors, spray equipment, and coating brushes are discussed in the following sections.

### Air Compressors

Air compressors are used in roofing to operate spray equipment (such as small air guns) and for dusting roofs that are to be reroofed. Occasionally, compressed air is also used to operate small air motors for other roofing equipment.

### Spray Equipment

Spray equipment (Fig. 8-15) is used largely for the application of protective coatings and primers on decks and foundation walls.

Special spray equipment is available for the application of combination chopped glass and asphalt

Courtesy Roofmaster Products Co.

**Fig. 8-12. Spudding bar**

**Fig. 8-13. Scoop shovel**

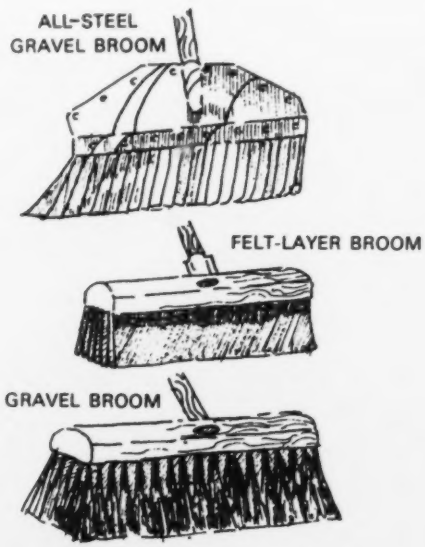
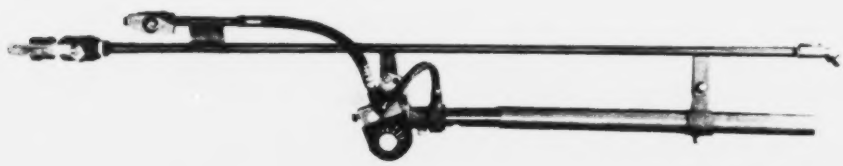



**Fig. 8-14. Brooms used in the roofing trade**



Courtesy Roofmaster Products Co.

**Fig. 8-15. Special spray equipment for applying chopped glass and asphalt emulsion**



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emulsions, such as Monoform. This equipment chops and sprays at the same time.

In setting up and operating spray equipment, roofers should:

1. Be sure adequate ventilation is available in closed areas.
2. Wear protective clothing, mask, and respirator.
3. Be sure pressure is not in excess of that required for the material and equipment.
4. Never spray when winds can blow the vapors onto finished surfaces.
5. Enclose V-belts and pulley drives.
6. Ground all non–current-carrying metal parts by using three-conductor cable and three-pole plugs and receptacles.

#### Coating Brushes

Brushes used for applying roof coatings are specially made. They have long handles and may be either of the three-knot or four-knot type.

### Roofing Brackets

Roofing brackets, or jacks, are required when work is performed on roofs of 1/4 pitch (6/12) or steeper. For spans of less than 10 feet (3.0 metres), lumber not less than 2 inches by 6 inches (5.1 centimetres by 15.2 centimetres) must be used. The roofing bracket for this size plank (Fig. 8-16) has three notches for fastening and can be used on all slopes, including 1/2 pitch (12/12). For spans of 10 feet, the lumber used must be 2 inches by 8 inches (5.1 centimetres by 20.3 centimetres). (Spans between brackets should not exceed 10 feet.) The roofing bracket for this size plank has a simple locking device to prevent accidental closing of the bracket.

### Hoists and Conveyors

The hoists and conveyors selected for moving equipment and materials to the roof will depend on the type of job being performed. In the case of new high-rise buildings, for example, the roofing contractor generally makes arrangements with the general contractor to use the latter's hoisting equipment. When this is not possible, the roofing contractor may use his or her own equipment or hire a hoisting company to provide the needed service. When reroofing a high-rise structure, the roofing contractor may use the freight elevator or, if none is available, a passenger elevator. Should this be necessary, the roofing crew must be sure that all care is taken to avoid damaging the elevator. Roof-mounted power hoists are available for heights up to 200 feet (70 metres) or more.

For lower buildings the roofing contractor usually uses one or several of the different pieces of equipment described below. The choice is governed by the requirements of the job.

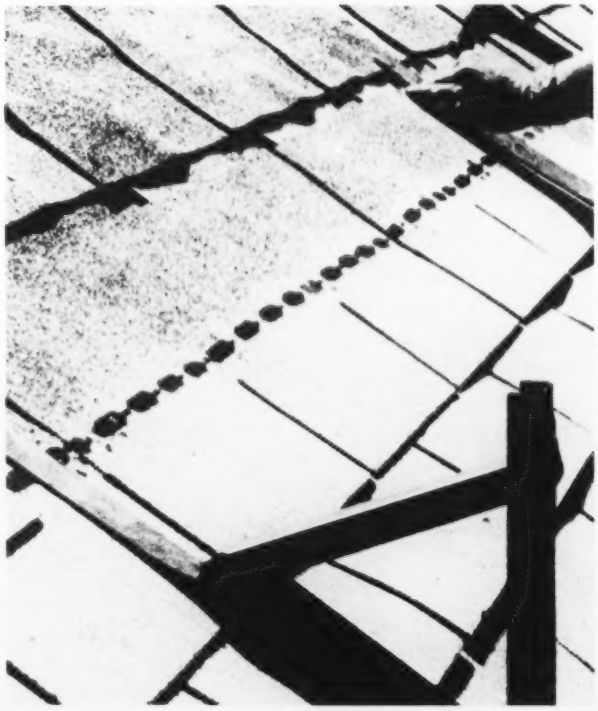


**Fig. 8-16. Roofing bracket for 2" x 6" plank**

#### Hoists

As a rule, hoists are capable of lifting things higher than are conveyors because conveyors must generally be set at a greater angle.

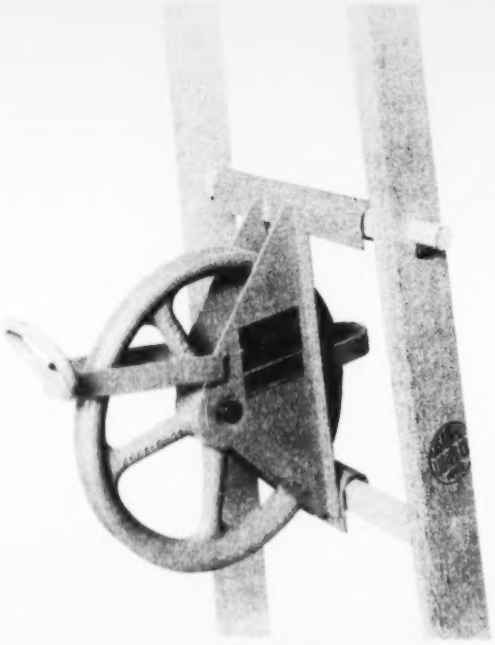
The types of hoists used for roofing are the derrick and winch, ladder-type (Fig. 8-17), ladder hand wheel (Fig. 8-18), power swing hoist (Fig. 8-19), trolley hoist (Fig. 8-20), and such lifting equipment as lift-bed trucks and forklifts. Derricks must be properly counterweighted.

An A-frame roof beam is used for handline hoisting. A variation of this is the swing type, which is used for handline roof hoisting as well as with the power winch. Various hooks, scoops, hoppers, forks, buckets, and tongs may be used with this equipment.

The motorized ladder-type hoist is adaptable to heights of 16 feet (4.9 metres) to 44 feet (13.4 metres)

Courtesy Roofmaster Products Co.

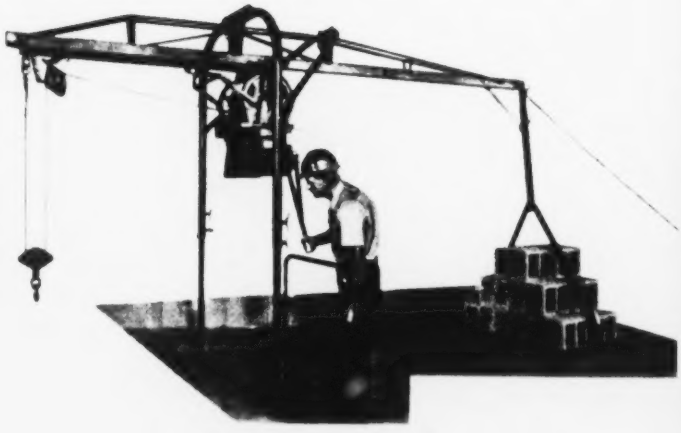
Fig. 8-17. Ladder-type hoist in operation



Courtesy Roofmaster Products Co.

Fig. 8-18. Ladder hand wheel

Fig. 8-19. Power swing hoist



Courtesy Cleasby Manufacturing Co.

Fig. 8-20. Trolley hoist



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(and sometimes more) and, with the addition of a bucket and hopper, may be used to hoist gravel.

A third type of hoist frequently used is the ladder hand wheel (Fig. 8-18), which is mounted on a standard ladder. It is suitable for buildings as high as two stories.

The power swing hoist (Fig. 8-19) has a boom that swings from side to side and is usually powered by a gasoline engine. Some power swing hoists can lift as much as 1,200 pounds (544 kilograms) of material.

The trolley hoist (Fig. 8-20) is also a powered hoist with a sliding trolley or monorail. This hoist is safe because it enables the roofer to bring the gravel bucket or load of material away from the edge of the roof so it can be handled in a safe manner. Most trolley hoists can handle up to 1,000 pounds (454 kilograms) of materials. It is important to check the manufacturer's specifications to determine the rated load capabilities and operating speeds for each hoist. The trolley hoist can be equipped with such attachments as hoisting forks and gravel buckets.

Lift-bed trucks have proved excellent for use with one-story structures. For use with higher buildings, the forklift is popular.

Operators of roof-edge hoisting equipment should always wear safety boots and a safety line securely attached to the building. The safety line should never be attached to the hoisting equipment. Workers who must work with or around hoisting equipment should also be thoroughly familiar with the hand signals shown in Fig. 8-21.

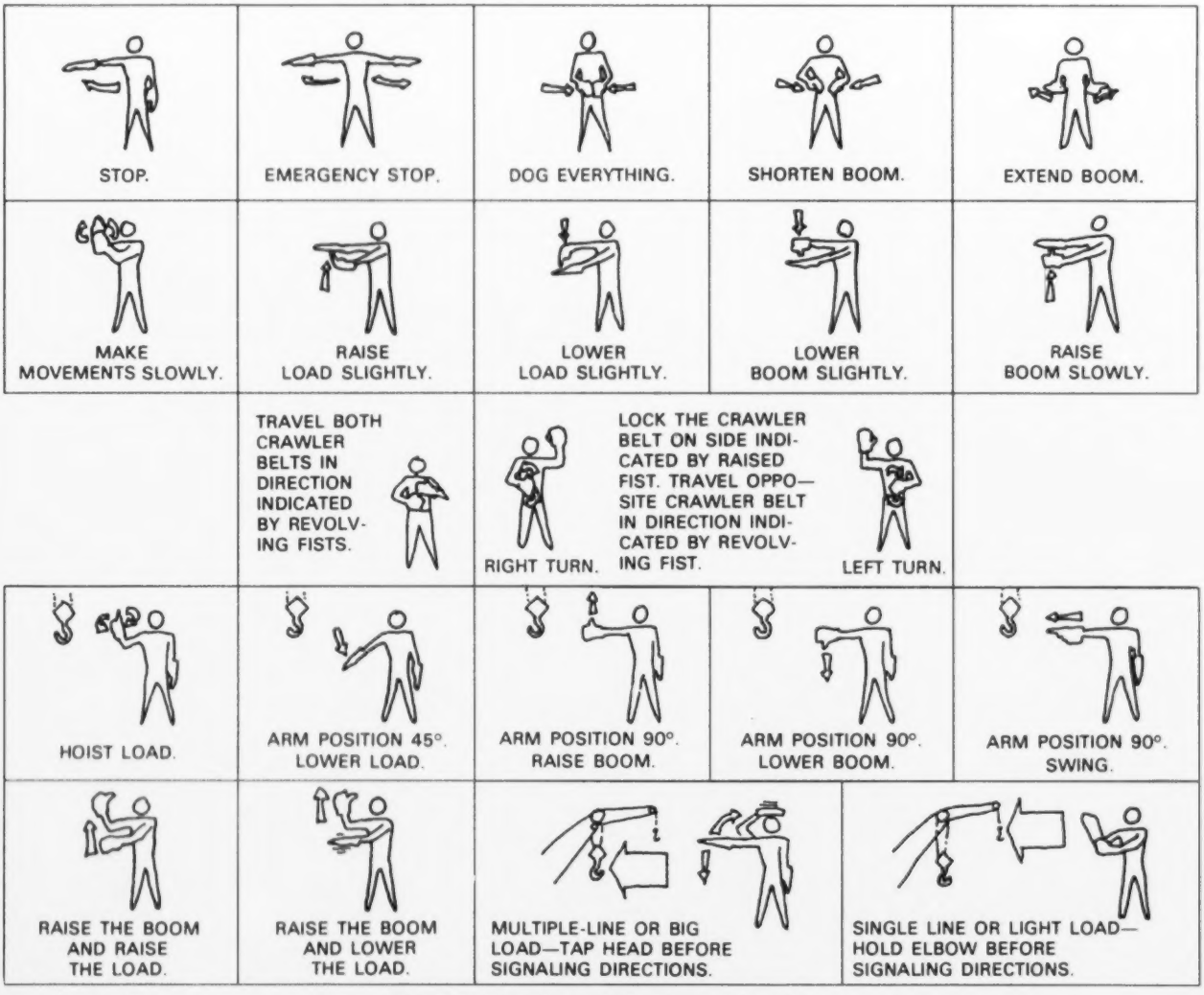
STOP.
EMERGENCY STOP.
DOG EVERYTHING.
SHORTEN BOOM.
EXTEND BOOM.
MAKE MOVEMENTS SLOWLY.
RAISE LOAD SLIGHTLY.
LOWER LOAD SLIGHTLY.
LOWER BOOM SLIGHTLY.
RAISE BOOM SLOWLY.
TRAVEL BOTH CRAWLER BELTS IN DIRECTION INDICATED BY REVOLVING FISTS.
RIGHT TURN.
LOCK THE CRAWLER BELT ON SIDE INDICATED BY RAISED FIST. TRAVEL OPPOSITE CRAWLER BELT IN DIRECTION INDICATED BY REVOLVING FIST.
LEFT TURN.
HOIST LOAD.
ARM POSITION 45°. LOWER LOAD.
ARM POSITION 90°. RAISE BOOM.
ARM POSITION 90°. LOWER BOOM.
ARM POSITION 90°. SWING.
RAISE THE BOOM AND RAISE THE LOAD.
RAISE THE BOOM AND LOWER THE LOAD.
MULTIPLE-LINE OR BIG LOAD—TAP HEAD BEFORE SIGNALING DIRECTIONS.
SINGLE LINE OR LIGHT LOAD—HOLD ELBOW BEFORE SIGNALING DIRECTIONS.

**Fig. 8-21. Hand signals for use with hoists**

Do not use roofing materials, such as rolls of felt paper or plugs of asphalt, as counterbalance weights to keep the power hoist secured to the roof deck. Counterweights should be at least two and one-half times the weight the hoist will lift on one occasion. (Fifty-pound [22.7-kilogram] blocks of concrete are commonly used as counterweights.)

### Conveyors

The main types of conveyors used by roofers are the continuous belt and continuous chain conveyors (Fig. 8-22) and the hydraulic conveyor. These conveyors can be transported easily, and they generally are equipped with buckets or hoppers for lifting specific materials.

Hydraulic conveyors should be operated only by personnel who are trained in their setup and operation.

Conveyors are not intended as a quick and convenient method for roofers to ride to the roof deck; serious injury could result from a fall from a conveyor.

*Courtesy Clear-Field Manufacturing Co.*

**Fig. 8-22. Continuous chain conveyor**

## Fire Extinguishers

Dry chemical fire extinguishers must be kept on all construction job sites; one or more should be maintained on both the roof and the ground. Dry-powder extinguishers are the most effective for smothering asphalt fires and for all small blazes. Carbon dioxide ($CO_2$) extinguishers are also used to smother flames. A spray-type fire extinguisher is less effective than a powder or foam type because wind tends to blow away the spray, whereas powder or foam, being heavier, creates a shield around a fire so that oxygen cannot get to it. A further consideration in choosing a fire extinguisher is the fact that neither the powder-type nor $CO_2$ leaves a permanent residue on the surroundings. Chart 8-1 provides additional information about the various classifications of fires, types of fire extinguishers and their contents, and methods of extinguisher operation.

When a fire occurs on the job site, the worker should:

1. Maintain an adequate distance from the fire when using an extinguisher. If the worker gets too close to the fire when using an extinguisher, the pressure from the extinguisher may blow the flames to other parts of the structure.
2. When using an extinguisher, the worker should hold it so that its discharge sweeps from side to side away from him or her. This will allow the worker to move up to the fire.
3. Regardless of the size of the fire, always call the fire department.

A fire extinguisher should be kept handy whenever workers are on the roof, and a clear way to get off should be maintained in case the roof should catch fire. When water must be used to extinguish an asphalt fire, it should be applied in a fine fog because a heavy spray spreads flames. Liquid should never be used on an electrical fire or where it might come into contact with electrical equipment. Fire extinguishers should be checked daily to be sure they are full and usable.

### Study Assignments

1. Read and/or review in trade journals and manufacturers' catalogs information on the types of equipment discussed in this topic.
2. Study the hoisting hand signals provided on page 42.



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Chart 8-1

**Types of Fires, Types of Extinguishers Approved for Use on Each Type of Fire, and Extinguisher Contents and Method of Operation**

| *Type of fire* | *Type of fire extinguisher* |
|---|---|
| **Class A**<br>Ordinary combustibles, such as wood, paper, and cloth | • Foam<br>• Soda acid<br>• Pump tank<br>• Gas cartridge<br>• Multipurpose dry chemical |
| **Class B**<br>Flammable liquids (such as gasoline, paint, and oils) and grease | • Foam<br>• Carbon dioxide<br>• Multipurpose dry chemical<br>• Ordinary dry chemical |
| **Class C**<br>Electrical equipment, such as motors and switches | • Carbon dioxide<br>• Multipurpose dry chemical<br>• Ordinary dry chemical |

*Extinguishers' contents and methods of operation*

1. The foam extinguisher contains a solution of aluminum sulfate and bicarbonate of soda. The foam should be discharged so that it falls lightly on the fire, especially on burning liquids (Class B fire).
2. The carbon dioxide extinguisher contains carbon dioxide gas under pressure. The operator should direct the discharge as close to the fire as possible, beginning at the edge of the fire and gradually moving it forward and upward.
3. The soda acid extinguisher contains a solution of bicarbonate of soda and sulfuric acid. The discharge should be directed in a stream at the base of the flames.
4. The pump tank contains plain water. The operator should place his or her foot on the footrest and direct the water in a stream at the base of the flames.
5. The gas cartridge extinguisher contains water that is expelled by carbon dioxide gas. The water should be discharged in a stream and directed at the base of the flames.
6. The multipurpose dry chemical extinguisher and the ordinary dry chemical extinguisher contain specially prepared powdered sodium bicarbonate. The discharge should be directed at the base of the flames. In the case of Class A fires, the dry chemicals should subsequently be directed at the remainder of the burning material.



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TOPIC 9

# Introduction to Kettles

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the difference between bottom-fired kettles and tube-type kettles.**
- **Identify the primary parts of a kettle.**
- **Describe the components and operation of an automatic kettle.**

THE importance of skillful kettle operation is too frequently underestimated by the employer and the apprentice. It is sometimes falsely believed that a good place to start a beginning apprentice is on the kettle. This is a serious mistake that has cost many thousands of dollars in loss of time, in injuries, and in roof failure.

An apprentice should never be assigned to kettle work until he or she has become familiar with the operation, and then only under the close supervision of a competent journey-level worker. Prior to actually trying to operate a kettle, the apprentice should become familiar with the safe handling of asphalt, observe the various methods of kettle operation, and learn the particular functions of different types of kettles.

Several types of kettles are used for heating bitumen. Liquid petroleum (butane or propane) kettles are those most commonly used.

When used or handled improperly, LP gas can be dangerous. For this reason, those who work with it and those who work near it must have some knowledge of its characteristics and of safe handling practices.

Because LP gas expands under heat, containers should never be filled completely. Such containers should also be equipped with an approved liquid level gaging device if they are designed to be filled by volume. Containers must be constructed to withstand the vapor pressure exerted by the expansion of their contents.

In California, LP gas containers must comply with the standards of the American Society of Mechanical Engineers (ASME) or the American Petroleum Institute and American Society of Mechanical Engineers (API-ASME). Containers approved by ASME bear the following symbol:

Containers approved by API-ASME carry this symbol:

## Bottom-Fired Kettles

Bottom-fired kettles are seldom used for roofing work because they take too long to heat. This type of kettle is so constructed that heat can be applied directly to the bottom of the inside shell, which holds the bitumen. Such kettles are commonly used, however, for heating bitumen for wrapping pipe with corrosion-proof materials and for street repair work; occasionally, they are used for roofing jobs requiring coal-tar pitch or asphalt.

## Tube-Type Kettles

Most kettles today use "tube-type" heating. These kettles are constructed so that heat is directed through a tube unit submerged in the asphalt (Fig. 9-1). The tube unit rests in the kettle, a few inches from the bottom. This allows the asphalt to surround the tubes completely, which results in more even heat distribution and more production.

A kerosene-heated kettle is fired by a burner that is supplied with a mixture of kerosene and air from a fuel tank with a capacity of about 20 gallons (75.7 litres). Protruding into the tank is a manually operated air pump. Air is mixed with the kerosene, and the mixture is forced through a hose into the burner.

The burner consists of a steel coil surrounded by a metal shell. The size of the coil and the number of coils vary. Small burners have fewer coils than larger ones

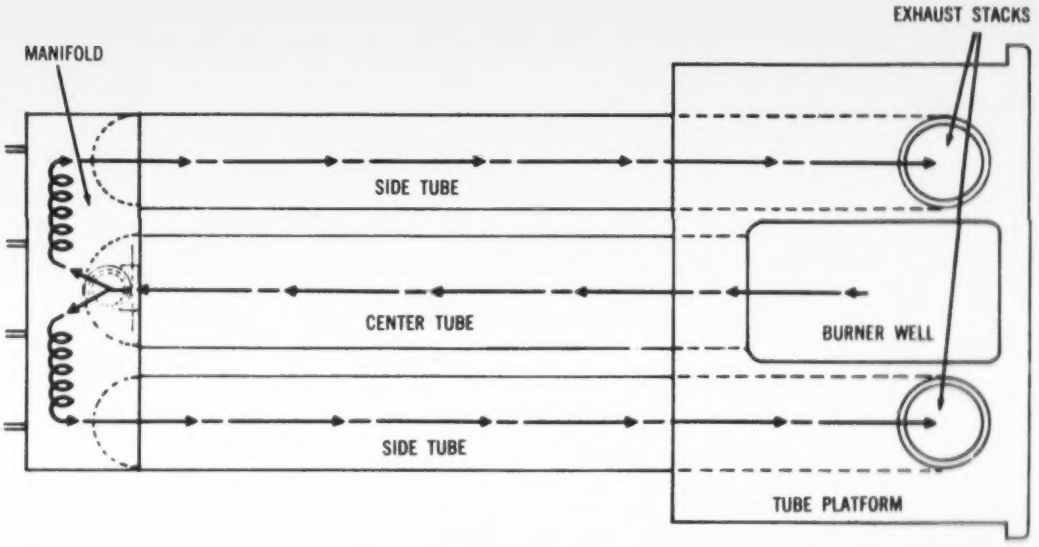



**Fig. 9-1. Tube arrangement inside a tube-type kettle. The heat generated by the burner (placed in the burner well) travels up the center tube into the manifold, where it circulates and escapes back through the side tubes to the exhaust stacks. Thus, the heat is evenly distributed throughout the kettle, avoiding "hot spots" that can cause carbonizing and flashing.**

and do not generate as much heat. Small burners are used mainly for patch work and small kettle operation.

Kettles heated with butane or propane (LP gas) burners are constructed the same as kerosene-fired kettles; however, the butane burner differs from the kerosene type in that no coils are necessary. The gas is fed directly to the outlet burner tip, where it mixes with oxygen from the air.

### Automatic Kettles

The automatic kettle is in general use throughout the country. This kettle is equipped with automatic heat controls.

The advantages of automatic controls are many, but the most important is that overheating can be controlled. This eliminates the need for the constant attention of the kettle operator to the heating process.

This type of kettle is fired by LP gas (propane or butane).

The major parts of an automatic kettle are the following:

1. Shell—The container in which bitumen is heated (Some kettles have a second shell inside the outer shell.)
2. Heating tubes inside the shell
3. Safety kettle cover to convey splashes and condensation back into the kettle
4. Exhaust stacks
5. Burners
6. Thermostat control for maintaining a uniform and safe temperature (Caution: Gages and thermostats should be checked periodically for accuracy.)
7. Pump for use in moving hotstuff from the kettle to the roof
8. Engine
9. Hotstuff control valve for regulating from the roof the flow of hotstuff from the kettle to the roof (The valve is controlled manually by means of an attached rope.)
10. Draw-off cock (spigot)
11. Third wheel, which allows one person to maneuver the kettle

**Study Assignment**

**Read and/or review in trade journals and manufacturers' catalogs information about the various types of kettles used in the trade.**

TOPIC 10

# Lighting and Loading of Kettles

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the procedure to be followed in lighting a kerosene burner.**
- **Describe the procedure to be followed in lighting an LP gas burner.**
- **Describe the procedure for lighting and loading a tube-type kettle using LP gas.**

EFFICIENT and safe operation of kettles calls for skills and attentiveness to an even greater extent than is required for other roofing jobs. There is no reason for burns, fires, property damage, or warped kettles if the proper practices are employed in lighting burners and in loading and operating kettles. In addition to the material presented in this topic, every apprentice should study the applicable sections of the *Construction Safety Orders* and Bulletin 124 of the Division of Occupational Safety and Health.

## Lighting Kerosene Burners

The proper procedure for lighting a kerosene burner is as follows:

1. Fill the kerosene tank, but never to capacity; allow air space above the fuel. Replace the filler cap firmly, using hand pressure only.
2. Use the hand pump to build up the air pressure inside the tank until the gage reads approximately 30 pounds (13.6 kilograms).
3. Open the valve on the tank (not on the burner) as far as it will go.
4. Open the valve on the burner about one-quarter turn, or just enough to allow the raw kerosene to trickle into the burner pan.
5. Shut off the burner valve when the burner pan is half full.

   *NOTE:* In this operation the burner should be placed in the ground. Do not open the valve too wide because a stream of raw kerosene may shoot out and flood the area. Should this happen, move the burner to a new area, well away from the spilled fuel, before lighting the burner.
6. Saturate a small piece of paper or cloth with kerosene, and place it into the burner to act as a wick.
7. Light this wick, and wait for it to ignite the kerosene in the pan. The flame will heat the generating coils, which contain kerosene supplied from the fuel tank. When the coils become hot enough, the kerosene contained within the coils will vaporize and, as the pressure of the vapor increases, the vapor will enter the orifice tip and ignite. A blue, roaring flame will be produced. The whole process is then said to be "generating." When a full flame is coming from the burner, open the valve on the burner slightly to adjust the flame. When the excess kerosene in the pan has burned out, place the burner in the burner well, and adjust the flame for the required heat. An adjustment in air pressure may also be required.
8. Use extreme care when adjusting the flame on a kerosene burner. If it has been operating on a low flame and the valve is suddenly opened, the coils may have cooled below vapor-point, which will cause raw kerosene to be ejected and ignite the surrounding area. (It is not a good practice to operate a kerosene burner on a low flame for a long period of time. The small, yellow flame tends to cause excessive carbonizing of the burner coils.)

## Lighting Butane and Propane Burners

Burners of the propane or butane type (usually referred to as LP gas or LPG) are not as difficult to operate as kerosene burners; however, they still require a competent kettle operator to operate them.

LP gas is supplied in high-pressure cylindrical tanks called "gas bottles." Those used by roofers are generally of the 25-gallon (94.6-litre) size, but those serving larger kettles may be 100-gallon (378.5-litre) or 200-gallon (757-litre) capacity. These larger tanks may be filled right on the job by an LP gas tank supply

truck. Kettle capacity may range from 85 gallons (321.7 litres) to 700 gallons (2649.5 litres); regardless of size, the recommended pressure is 25 pounds (11.3 kilograms).

Gas bottles should be equipped with pressure regulators; the initial pressure of the gas is at least 100 pounds (45.4 kilograms). The regulator allows the gas to flow from the bottle to the kettle burner at a lower rate of pressure, such pressure determined by the size of kettle being fired. The hose connecting the regulator to the kettle burner must be of the approved type, manufactured specifically for use with LP gas. Hose fittings must never be allowed to become bent out of shape or loose.

When using LP gas, do the following:

1. Open the valve on the gas bottle.
2. Light the wick or lighting lance, and place it in the burner well in front of the burner.
3. Open the burner valve just enough to release sufficient gas so that the burner may be lighted. Some LP gas burners are equipped with pilot lights so that the burner may be turned off when the kettle gets hot and relighted by the pilot when needed.
4. Replace the wick or lance in the holder.
5. Open the burner valve and adjust the burner gradually to operating temperature.

Remember that it is not a safe practice to idle a gas burner down to the point where the flame is not strong enough to flow completely through the center tube or to heat full blast when firing a cold kettle. This will cause tubes to burn through much faster. Too small a flame will create hot spots along the center tube, which may lead to flashing. Never operate a kettle with a tube that has burned through.

### Lighting Automatic Kettles

Most automatic kettles operate on LP gas. The pilot light is lit first and acts as a pilot generator, developing sufficient electricity to hold the safety valve open. The thermostat is then set to the desired temperature, and the burner goes on automatically. It stays on until the bitumen reaches the proper temperature. At this time the burner goes off and remains off until the temperature of the bitumen drops by about 13° F (7.2° C). Then the burner goes back on, and this cycle continues until the burner is shut down. *NOTE:* If the kettle has a manual switch, this switch should be in the "Off" position when the kettle is operating on automatic.

If for any reason the pilot light is extinguished, the safety valve immediately cuts off the flow of gas to the burner to prevent raw gas from escaping.

### Loading Tube-Type Kettles

Proper loading of a kettle is as important as any other skill in the roofing trade. If the kettle is empty, or nearly so (that is, when the tubes are exposed above the bitumen), the kettle should not be fired up. Sufficient bitumen to surround and cover the tubes should be added. The bitumen should be chopped into small pieces. The burner may then be placed in the burner well with a low flame. This will start the bitumen melting gradually, without flashing or burning. If a high flame is used, the bitumen may ignite before it is melted.

After the bitumen in the kettle is melted, additional chunks of slightly larger size may be added until the kettle is about three-fourths full. This method will allow space for additional bitumen should the kettle become overheated. It will also decrease the danger of flashing because of overheating.

When the bitumen is completely melted, the flame should be adjusted to maintain an even heat. This should be done by regulating the valve on the burner—not the valve on the tank. In actual practice the tank should always be wide open, and the flame should be adjusted only at the burner valve. Most kettles are equipped with a thermometer that shows the temperature of the liquid. As hot bitumen is drawn off, additional chunks are fed into the kettle to maintain the proper level. The burner flame may need to be adjusted from time to time, depending on the thermometer reading during drawoff and feeding periods.

A good kettle operator will always have an ample supply of bitumen chopped and ready for feeding so that when there is a large draw of hotstuff, he or she can immediately bring the kettle load up to the desired level. A kettle operator who has learned to coordinate drawing off, feeding, and uniform temperature can keep a crew of roofers supplied with hotstuff.

If a kettle is partly filled with cold bitumen in solid form when the kettle is to be lit for the day's work, and the tubes are well covered, the lighting procedure explained previously must be followed,

except that no bitumen need be added until the bitumen present has melted.

Barriers or pylons should be placed around the working area of kettle operation to protect bystanders. Only experienced and properly trained personnel should be within 20 feet (6.1 metres) of a hot kettle.

**Study Assignment**

Read and/or review in catalogs and other literature from kettle manufacturers information on lighting and loading the various types of kettles used in the industry.

TOPIC 11

# Kettle Heating

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the results of overheating bitumen.**
- **Describe the safety procedures the kettle operator should follow in heating bitumen.**

THE heating and melting of bitumen (asphalt) are important aspects of kettle operation; the kettle operator plays a major part in achieving the desired durability of the completed roof assembly. Kettle design and construction have progressed over the years from crude wood-fired units to units heated by fuel oil, kerosene, and gas; from bottom-fired kettles to tube-type units; and from guesswork temperature control to highly accurate automatic heat controls. The result is the modern engineered high-temperature, fully insulated kettle that serves today's roofing needs.

These modern kettles, when properly maintained and operated, will produce hot material in sufficient quantities to keep pace with other labor-saving methods and devices that are now employed in the application of built-up roofs.

Improper operation, on the other hand, will nullify many of the advantages now offered by today's equipment. In the following paragraphs some of the problems involved in kettle operation are discussed.

## Overheating of Bitumen

Roofing materials manufacturers have set specific temperatures to be maintained if the bitumen is to give the required service and longest roof life. If asphalt is heated over the manufacturer's recommendations, the more volatile oils will be driven off in the form of vapors—and the loss of these will cause the asphalt to carbonize and become brittle, thereby drastically shortening the life of the roof.

Coal-tar pitch should never be heated over the manufacturer's recommendations. Above such temperature, loss of vapors begins to occur at an inverse ratio for each degree of rise, since these oils are even more volatile than those in asphalt. Among the chemicals dissipated in this way are napthalene, phenol, and carbolic and creosote oils, which are the life-giving properties of pitch.

In addition to the loss of useful life, another result of overheating pitch and thus releasing these chemicals in vapor form is severe irritation to skin and lungs. The kettle operator and the moppers will be exposed to these fumes, which can cause burning of the hands, face, neck, and any other unprotected areas of the body. Protection from this danger is discussed in Topic 5, "Safety in the Industry."

These escaping vapors usually have a yellow-green appearance. Should they turn a vivid orange color, the kettle can be expected to flash. When this happens, the burner should be turned off immediately and the kettle lid closed to cut off the oxygen. After the fire is extinguished, extreme care should be used when opening the lid, because escaping vapors may flash again. After the lid is opened, small chunks of coal-tar should be added to help lower the temperature. The burner should not be relit until the kettle has cooled well below the flash point. The kettle operator should be aware of the flash point of the material he or she is heating.

## Results of Overheating

Overheating damages the kettle, causing tubes to warp and leak. This allows molten asphalt to enter the fire chambers, creating a dangerous condition. The kettle shell may warp out of shape as a result of severe overheating and resultant flashing. For this reason, a kettle operator should keep the outer surfaces of the kettle clean; the accumulation of pitch and asphalt on the outer shell and tires of the kettle is one of the largest factors in creating this hazard. Once the tar on the

outside of a kettle begins to burn, it is almost impossible to extinguish. Such fires will often damage equipment to the extent that replacement of parts, or even the entire kettle, will be necessary. A cardinal rule in roofing can be stated simply: "A clean kettle won't burn."

To ensure that a mopping of asphalt is not too light (causing incomplete coverage) or too heavy (causing poor adhesion, high expansion properties, and low tensile strength that can lead to roof splits), an optimum temperature range during the asphalt application process is extremely important. This optimum temperature range is described as the "equiviscous temperature."

Excessive heat in kettle operation is also the cause of carbon formation around the tubes, resulting in heat loss, much longer heating time, and increased danger of fire. Both fuel and person-hours are wasted when this condition exists.

The kettle operator has full responsibility for ensuring that the kettle does not overheat.

Kettles should always be operated in accordance with the manufacturer's operating instructions. Operating procedures may change, however, as a result of safety regulations, air pollution regulations, or changes in the material being melted.

### Importance of Kettle Size

Overheating is frequently caused by using a kettle that is too small for the job. The usual result is that the kettle operator is tempted to "push" the operation, in an attempt to run too much material through in too short a time. To do this, he or she must raise the bitumen temperature well above normal level, which results in overheating of the bitumen. Either more than one kettle should be used to reduce this demand, or, if possible, a single, larger-capacity kettle should be substituted.

On any job requiring the delivery of hotstuff as one of the first operations of the day, the kettle should be fired at least 1 hour before the crew arrives. If the kettle is fired at the same time as the crew arrives on the job, overheating may result as the kettle operator "pushes" the burner in an attempt to hasten the preparation of hotstuff.

The kettle operator must also watch the progress of the roofing operation closely so that the supply of hotstuff does not get too low. He or she should know how much of the hotstuff will be required on a particular job and when it will be needed. For example, on a job that is to be "graveled in," he or she should ask the supervisor to notify him or her at least 1 hour before pouring operations are to begin so the supply can be made ready.

The kettle operator should always bear in mind the following rules:

- A fire that is out of control can cause serious damage to the equipment and the surrounding area. If the fire cannot be controlled at once, call the fire department.
- During the heating operation an approved protective lotion should be used by the kettle operator on all exposed skin areas to prevent burning from coal-tar fumes.
- Respirators and eye protectors should be used when coal-tar pitch is heated or used in confined areas where there is inadequate ventilation.

**Study Assignment**

Read and/or review in manufacturers' catalogs information on heating the various types of kettles used in the trade.

TOPIC 12

# Kettle Cleaning and Maintenance

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the procedure for cleaning and maintaining a kettle.**
- **Identify the causes of flash fires in kettles.**
- **Clean and maintain a kettle.**

A good kettle operator is a systematic worker. Through proper maintenance of equipment, he or she can save many dollars in overhead expense and, in addition, can help keep jobs on schedule by supplying the required amount of hotstuff when it is needed. Cleaning and maintenance are parts of the kettle operation and if performed regularly and properly will result in efficient operation and delivery and will minimize work stoppages and slowdowns.

## Kerosene Burners

Kerosene burners should be kept clean and free of carbon if they are to function properly. A burner that has a bent shell, pan, or plugholder will not function as it should. The following are some rules for long service life:

- Clean the strainer on the burner valve periodically.
- Inspect hose fittings. Loose fittings are a fire hazard.
- Do not pound burners on the ground to loosen carbon deposits. This will throw the plugholder out of alignment with the flare tube and coil and loosen the fittings, causing them to leak.
- Keep an extra vaporizing plug and a cleaning needle handy.
- Use only a top grade of clean fuel oil or kerosene.

## LP Gas Burners

Liquid petroleum (LP) gas burners require little maintenance. The tips should be removed periodically to clean out any residue that may have seeped through from the tank. Before lighting, always wipe the burner with a clean rag to remove any accumulated dirt or soot.

## Kettle Shell

The exterior of the kettle should be cleaned at least once a week, and more often if possible. This should be done while the kettle is hot. A large putty knife can be used to scrape the tar from the lid, top, sides, front end, rear end, and fenders.

The interior of the kettle should be cleaned whenever there is a large buildup of carbon or coke or whenever the following trouble signs appear:

- Excess carbon around the exhaust stacks and under the tube platform
  1. This condition creates a fire hazard and can cause a fire that is difficult to extinguish because of the accumulation of oil-soaked carbon.
  2. Under such condition, the kettle lid will not close tightly because of the carbon, dirt, and gravel under the platform. This will cause the top of the kettle to warp.
  3. Excessive carbon buildup takes up usable space for asphalt and can, for example, reduce the capacity of a 230-gallon (870.6-litre) kettle to 175 gallons (662.4 litres). An 18-inch by 18-inch (45.7-centimetre by 45.7-centimetre) chicken wire screen framed with 1-inch (2.5-centimetre) boards and having a 5-foot (1.5-metre) handle can be used to remove excess carbon and asphalt-paper wrappers floating on top of hot asphalt.
- Excess carbon buildup around the pump (submerged pump)
  1. This can cause the check valve in the siphon pipe of centrifugal pumps to become jammed open or closed.
  2. An accumulation of carbon around the strainer will result in a loss of asphalt flow to the roof.
- Decrease in kettle production or failure of the kettle to heat
  1. Carbon on the kettle bottom may be partially covering tubes.

2. Hard carbon on the center tubes and manifold will prevent heat from getting through tubes and into the kettle.
3. Gravel or dirt from the outside of the bucket used in cleaning the kettle may be covering tubes.

- Extreme variations in the temperature of an automatic kettle within a short period of time—this condition is caused by carbon buildup around the thermostat sensing tube; the burner stays on too long or not long enough.
- Flashing
  1. Flashing occurs frequently when carbon builds up excessively in the areas mentioned above.
  2. Flashing can be caused by a leak in the LP gas tank; vapors drifting over the kettle when the burners are on can ignite.
- Asphalt dripping into the burner well or asphalt smoke coming from the exhaust stacks—this condition is usually caused by asphalt leaking from a crack in the tubes. Carbon around a crack can also break loose and flood the tubes. *NOTE:* A smoking kettle may result in a citation from the Air Pollution Control Board of the local Air Pollution Control District. In California a contractor may be cited and fined if his or her equipment emits smoke for more than three minutes in an hour.

### Other Kettle Maintenance

The following are some additional practices that should be observed to keep kettles clean and properly maintained:

- Keep the sensing tubes for the thermometer and thermostat free of carbon and other residues.
- Check the accuracy of the thermometer and thermostat every 30 days with a portable thermometer. Remember that asphalt is hotter at the top of the kettle than it is down near the tubes because the cold asphalt that is added sinks to the bottom, where it melts before rising to the top.
- When it is necessary to clean the inside of the kettle, run the kettle down as far as possible on the job; run any remaining hotstuff into buckets and set these aside. The tubes, which are usually secured to the shell by two bolts on each side of the burner exhaust stacks, should be removed while the kettle is still hot. The tubes can be removed from some kettles without removing the kettle lid. It is advisable to use a hoist to lift the tubes from the kettle. Tie a rope or chain from the exhaust stack to the handle on the manifold end of the tubes. The tubes can be lifted straight out or at a slight angle, with the burner-well end slightly higher than the manifold end.

The inside of the shell should be cleaned at once since the carbon and sludge are more easily removed while still hot. Scrape down the inside, and shovel out the sludge. If the draw-off cock has not been functioning properly, remove it and clean or repair it. Clean the kettle screen by scraping and gently tapping on the debris that has accumulated on the mesh.

Use a scraper or spade to remove carbon from the tubes. If hard carbon is present, remove it from round tubes by gently tapping them with a hammer. Wear goggles when hammering. On flat-sided tubes, however, carbon should be scraped off because hammering can split or puncture this type of tube. Never hammer on an old, weak set of tubes. Goggles should be worn to protect the eyes whenever such hammering is done.

When reassembling the kettle, replace all defective parts. Use extreme caution when replacing the draw-off cock so as not to strip the threads. Wheel bearings should be inspected and packed with grease every 12 months or 2,000 miles (3218 kilometres).

Check the engine oil level daily, and add oil if necessary. Change the oil every 24 hours of use.

The hotstuff that was drawn off into buckets at the beginning of the operation can now be poured back into the kettle, provided that it is free of sludge. If it is not, simply discard it in an area that has little traffic. The kettle should now be ready for reloading and firing.

### Safety Reminders

In cleaning and maintaining kettles, be sure to observe the following safety precautions:

- Remove the burner before cleaning the kettle.
- Wear a long-sleeve shirt and gloves during the cleaning process to prevent burns.
- When pouring hot asphalt back into the kettle, take care to raise the bucket high enough to clear the kettle top, and pour slowly and evenly to avoid splashing.
- Use extreme care not to strip the threads when replacing the draw-off cock.

### Study Assignment

**Review kettle manufacturers' catalogs and kettle specifications for the various types of kettles used in the trade.**

TOPIC 13

# Roof Pumps

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the differences between heavy-duty pumping systems and submerged pumping systems.**
- **Identify the major advantages and disadvantages of each type of pumping system.**

For many years the only method of hoisting hot asphalt or pitch from the ground to the roof was by hand, using buckets. This was a slow and dangerous method. Nearly 70 percent of all roofing accidents are attributed to the handling of hotstuff in buckets.

Around 1948 a system of pumping hot asphalt was devised, using an engine and pump mounted on a frame that sat on the ground next to the kettle. A flexible metal hose was used to draw the asphalt from the kettle to the pump, which then elevated it to the roof, where it bypassed a draw-off cock mounted on a roof stand and returned on another line to the kettle. In this way, the hotstuff could be kept circulating through the system and, at the same time, could be drawn off at the roof by using the draw-off cock to supply the material to buckets, carts, or highboys as needed. When the draw-off cock was again closed, the continuous circulation was reestablished. This method of pumping was known as the "double-line" system, and its main drawback was that considerable cooling of the material occurred as it traveled from the kettle to the roof and back to the kettle. This system generally required a larger kettle than would otherwise have been used just to keep the material at usable temperature.

Later, a kettle-mounted pump with a single line to the roof was developed. This new system greatly increased pump efficiency and lowered costs. This newer, now popular system is described in detail in the following discussion on heavy-duty pumping systems and submerged pumping units.

## Heavy-Duty, Single-Line Asphalt Pumping System

The most efficient system yet devised for elevating hot asphalt from the kettle to the roof is the single-line pumping system. Basically, this system consists of a circulating unit mounted within the kettle (Fig. 13-1). An engine of approximately 8 horsepower drives the pump, which circulates the hotstuff from the pickup point to the discharge point within the kettle. The grease zerk on the pump should be lubricated at least once each day.

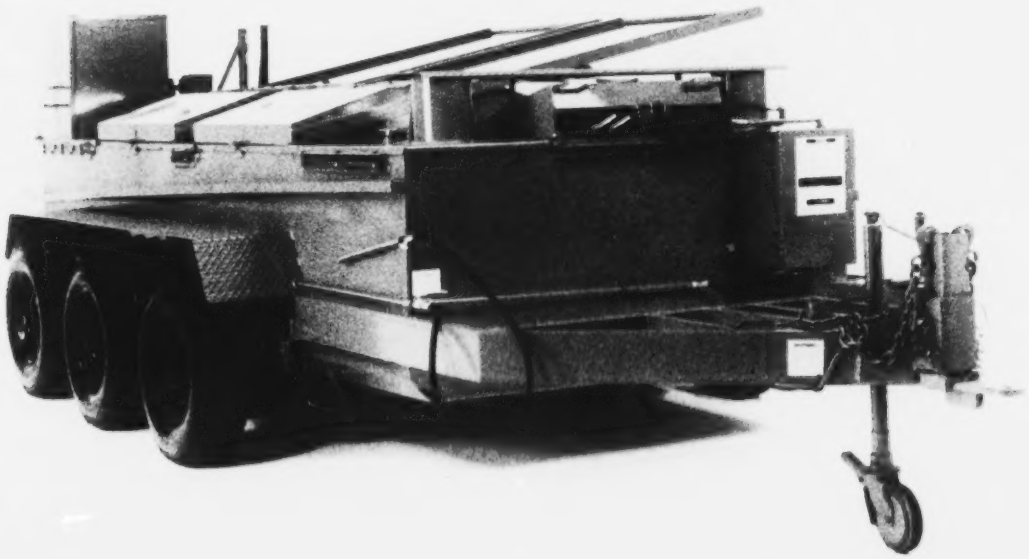
In the pumping process the hotstuff passes through a line on which is installed a quick-acting valve. Whenever this valve is in the open position, the hotstuff circulates continuously.

To elevate the hotstuff to the roof, the roofer simply pulls a control rope to close the line's valve. The hotstuff is then directed through a single line to the roof, where it is received in whatever receptacle is being used for the purpose, usually a 30-gallon (113.6-litre) highboy. About 1 minute is required to fill a receptacle of this size. The highboy should be free of moisture before the hotstuff is placed in it. When the rope is released, the quick-action valve on the circulating system is pulled open by a spring on the valve's lever, and continuous circulation of hotstuff is once again established. The hot material left in the line is returned to the kettle by means of a gravity drop and siphoning action.

The supply line to the roof is generally made of thin-wall metal tubing, which is available in lengths of from 5 to 20 feet (1.5 to 6.1 metres). Through the combination of different lengths, any desired height can be obtained. At the roof level a flexible metal hose is used as a filler pipe to the receptacle. The pipe should be checked for moisture before pumping begins.

The following are the main advantages of this type of system:

1. Temperature loss is kept to an absolute minimum, usually running about 20° F (11.1° C) for a 60-foot (18.3-metre) elevation. The hotstuff therefore remains at a temperature that allows for easy mop-



Courtesy Cleasby Manufacturing Co.

**Fig. 13-1. Typical 1,200-gallon (4542-litre) thermostatically controlled, single-line heavy-duty pump kettle**

ping; overheating in the kettle is not required. *NOTE:* Temperature control can be improved by insulating the tubing with roll insulation (with the foil side placed toward the tubing).

2. The engine, pump, and supply lines are all attached directly to the kettle, which saves considerable time and effort over that required by a ground pump.
3. Thin-wall tubing is simple to erect and easy to handle because of its light weight. (A 20-foot [6.1-metre] section of such tubing weighs only 19 pounds [8.6 kilograms].)
4. This type of pumping system has been used to carry hotstuff to heights of over 150 feet (45.7 metres).

### Submerged Pumping Systems

Another type of pumping system, known as the submerged pumping unit, consists of a pump, either rotary gear or centrifugal, mounted inside the kettle and immersed in the bitumen. An engine is mounted on the rear platform of the kettle and connected to the pump by means of a drive shaft.

When the pump is operating, a continuous circulation of hotstuff is maintained. The hot material is picked up at one point in the kettle and elevated to a line mounted just above the kettle platform. It is then returned to the kettle, a short distance from the pickup point.

A quick-opening valve is mounted on this line. When in the open position, the valve allows continuous circulation from the kettle to the line and back to the kettle. To elevate the hot material to the roof, the roofer has only to pull on a control rope, which closes the line valve, and the material is diverted to the line of thin-wall tubing running up to the roof, where the hotstuff is run into a receptacle.

The main advantage of the submerged system is that the pump, being immersed in the bitumen, is hot whenever the bitumen is hot, and the operation begins as soon as the engine is started.

The major disadvantage of the submerged system is the possibility of having to drain the hotstuff if a maintenance problem occurs.

**Study Assignment**

Review the manufacturers' specifications for the two pumping systems discussed in this topic.

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TOPIC 14

# Tankers

This topic and the related instruction classes are designed to enable the apprentice to do the following:

- **Describe the difference between early tankers and those used today.**
- **Identify the types of burner control systems used on tankers, and describe how they differ.**
- **Describe the major advantages of job tanks and yard storage tanks.**

## Bulk-Asphalt Tankers

THE use of bulk-asphalt tankers (Fig. 14-1) for roofing operations is not new. As long as 35 years ago, a few roofing contractors used tankers on very large roofing jobs. These contractors were able to see that they could derive considerable savings in materials costs and labor costs by having a supply of 2,000 gallons (7570 litres) or more of liquid asphalt ready to pump to the roof.

The first tankers were generally converted oil transports or milk transports. Some did not even have heating tubes in them. The asphalt was heated by circulating it through a kettle and then returned to the tank. In some cases asphalt was brought to the job site in railroad tank cars equipped with steam pipes in their interiors. The asphalt was heated by pumping steam into the pipes with a steam generator. Through the use of this method, asphalt could be kept at a temperature of approximately 400° F (204.4° C). The asphalt was then pumped through a kettle and to the roof.

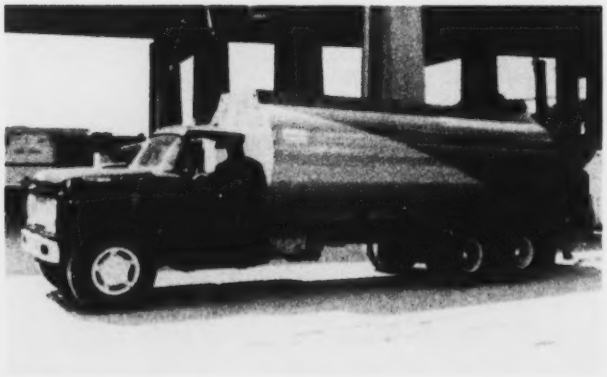

**Fig. 14-1. Typical bulk-asphalt tanker**

Much has been learned about holding, heating, and pumping asphalt from tanks of various sizes. Most tankers and storage tanks (Fig. 14-2) in use today have built-in safety systems by means of which the operator can readily determine the temperature of the asphalt and the level of the asphalt above the heating tubes. An adjustable siphon pipe is used to determine the level of asphalt in the tank. Adjustments are made by means of a chain attached to the siphon pipe. Generally, the siphon pipe is kept about 10 inches (25.4 centimetres) above the heating tubes. The operator must always know how much asphalt is in the tank before firing the burners. The burners should not be operating when the siphon pipe is lowered.

## Burner Control Systems

Most tankers and storage tanks are equipped with an automatic burner control system. However, some have a semiautomatic system or a manually operated system.

### Manually Operated Burner Control Systems

The operator of a manual burner control system must be continually aware of the asphalt level in the tank and must check the thermometer frequently. The burner should not be fired unless the asphalt level is at least 6 inches (15.2 centimetres) above the heating tubes.

### Semiautomatic Burner Control Systems

The semiautomatic control system is probably the best system when using exterior open-flame burners. This system requires the operator to start the system manually and set the thermostat to the desired temperature. When the asphalt reaches that temperature, the burner shuts down. Once the burner has shut down for



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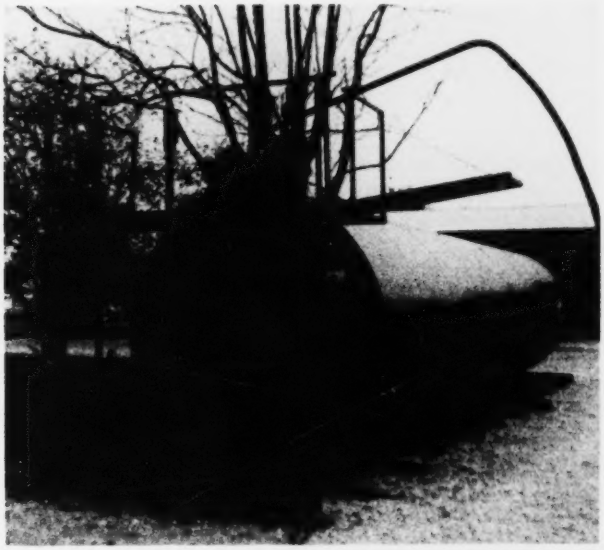

Fig. 14-2. Typical storage tank for asphalt

any reason, the operator must restart it manually. When restarting (or starting) the burner, the operator must be sure that the flue(s) on the top of the tanker are open. Butane tanks and other flammable materials must be kept a safe distance from tankers and kettles.

#### Fully Automatic Burner System

Fully automatic burner control systems are usually found only on ground-mounted storage tanks. Several manufacturers, however, have made this system available on smaller job tanks (7.5 tons to 37 tons [6.8 metric tons to 33.6 metric tons]).

**Study Assignment**

Review all available information on asphalt tankers and storage tanks.

## Instructional Materials Required for Each Apprentice

*CAL/OSHA, State of California Construction Safety Orders* (Current edition). Los Angeles: Building News, Inc. (Orders to: Building News, Inc., 3055 Overland Avenue, Los Angeles, CA 90034.)

*Uniform Building Code* (Current edition). Whittier, Calif.: International Conference of Building Officials. (Orders to: International Conference of Building Officials, 5360 S. Workman Mill Road, Whittier, CA 90601.)

## Glossary

THE definitions of terms included in this glossary are those that are pertinent to the roofing trade and are not necessarily those found in standard dictionaries. Some of the terms included are colloquial in nature and are used with the meanings applicable only to the roofing trade.

*A-frame*. A portable frame built in the shape of the letter *A* and used by roofers to hoist materials.
*Apex*. The point, tip, or summit of anything; the highest point of any roof or structure.
*Arch*. A curved or pointed structural member that is supported at the sides or ends; to cover with a curved structure or to form a bent top or covering.
*Asphalt*. A brownish-black, natural petroleum residue used in applying roofing.
*Beam*. A long piece of timber or iron used to support the rafters of a building; a horizontal timber or support.
*Bevel*. To give a sloping edge; to slant or incline. (T bevel: a tool used to test the accuracy of beveled edges.)
*Bitumen*. Coal-tar pitch or asphalt.
*Boom*. A strong chain, cable, or line; a long pole attached to a derrick to steady or guide in hoisting.
*Brace*. A piece of wood or other material that holds anything tightly or supports it firmly; a prop.
*Building Code*. Governmental rules and regulations for building.
*Built-up roof*. A roof formed by a number of layers of roofing mopped together with hot asphalt or pitch.
*Cable*. A heavy rope or chain.
*Canopy*. An overhanging covering.
*Cantilever*. A projecting beam supported at only one end.
*Cant strips*. Triangular shaped material installed on a roof deck in the angles formed by the intersection of vertical and horizontal surfaces.
*Canvas*. A heavy, strong cloth used for roofing decks.
*Cap sheet*. A finish roofing material used as a covering for a roof.
*Caulk*. To make watertight by plugging with mastic.
*Chalk line*. A heavy string or cord used for lining purposes.
*Chicken ladder*. A lightweight ladder used to hang over the ridge on steep roofs.
*Circumference*. The perimeter of a circle; a line that bounds a circular plane surface.
*Cleat*. A strip of wood or metal fastened across other materials for additional strength; may be nailed against the wall for supporting an object.
*Coal-tar pitch*. A thick, dark liquid obtained by distillation of soft coal; used for roofing and waterproofing.
*Coating liquid*. A liquid with an asphalt or coal-tar base used for preserving roofs.
*Connection*. The act or means of joining or uniting.
*Coping*. The top covering of a wall; may be metal, tile, masonry, or wood.
*Cornice*. A horizontal molded projection at the top of a building; also the plastered underside of the eaves.
*Cupola*. A hemispherical roof; a small structure above the roof.
*Curb*. A protective rim.
*Cured*. Completely dry; moisture free.

*Cutback.* Asphalt dissolved into its liquid form.
*Dampproofing.* The application of coatings of hot or cold bitumens or the use of membranes to keep out dampness.
*Debris.* Accumulated rubbish, trash, and fragments of roofing.
*Deck.* The roof surface to be covered; a small platform used for walking.
*Derrick.* A framework, with a long beam, ropes, gear, and pulleys, used for hoisting heavy weights.
*Detail.* One of the many minor parts into which a building may be divided; a drawing of such a part.
*Diagonal.* Crossing obliquely as from corner to corner.
*Diameter.* A line through the center, as of a circle or sphere, terminated at the boundary thereof.
*Dormer window.* A vertical window rising from a sloping roof.
*Dragline.* A guideline rope.
*Eaves.* The projecting lower edge of a roof.
*Firewall.* A wall erected above the roof to block fires between sections of the building.
*Flash point.* The temperature at which asphalt or tar, when slowly heated, gives off vapors that will ignite upon the application of a flame.
*Flue.* A channel or passage for smoke or gases of combustion; a chimney.
*Flush.* A term applied to surfaces that are level and form a single unbroken surface.
*Gable roof.* A ridged, double-sloping roof.
*Gambrel roof.* A gable roof with its slopes broken by an obtuse angle; a gable roof with two pitches in one field.
*Gauntlet.* A modern glove with a long wrist extension.
*Girder.* The large supporting, spanning beam of a roof; a main spanning beam.
*Hand line.* A rope used by hand to hoist light loads.
*Hatch.* An opening in the roof; an access hole to the attic.
*Hexagon.* A figure with six sides.
*Hip roof.* A roof having sloping ends, thus four sloping sides. The line where adjacent sloping sides meet is called a hip.
*Hoist.* A hoisting machine; to pull up.
*Horizontal.* In the direction of the horizon or parallel to the horizon.
*"Hotstuff."* Term used for asphalt or coal-tar pitch after it has been heated.
*Incline.* A slope; a sloping surface.
*Jack, roof.* A device used in scaffolding a roof; a flashing used to cover pipes and vents.
*Joint.* The point at which two or more surfaces are united.
*Joist.* A horizontal timber to which the boards of a floor or lath on a ceiling are fastened.
*Kerosene.* A light, colorless petroleum fuel used in kettle burners and for cleaning purposes.
*Kettle.* A metal vessel for heating asphalt or coal-tar pitch.
*Kettle operator.* An individual who operates a kettle.
*LP gas.* A liquid petroleum product (butane or propane) used as fuel on certain kettle burners.
*Lead.* A bluish white metal used for pipes, roofs, and gutters.
*Lean-to roof.* A roof sloped one way; a shed roof.
*Lining.* Marking of a roof with a chalk line.
*Marquee.* A covered roof extending out from a building.
*Mastic.* Thick adhesive mixture of preparations such as asphalt; used for repairing roofs.
*Mission tile.* A curved tapering tile unit.
*Molding.* A cornice or projecting decorative member used on any part of a building.
*Nailing strip.* A strip of wood set in concrete along the eaves or gable of a roof.
*Nail (roof).* A nail with a large head.
*Nipper (tile).* A tool with jaws for gripping and cutting tile.
*Overhang.* The length of rafter projecting beyond the wall line.
*Parapet.* A low wall above the roof level.
*Pitch.* The slope of a roof, indicated by the relation of the rise to the span; also a coal-tar roofing material.
*Plastic.* Waterproofing material, composed of coal tar, asphalt, asbestos fibers, and so on.
*Pot.* Roofing kettle.
*Pry bar.* A long heavy steel bar, pointed or wedge-shaped at the working end.
*Pulley.* A wheel grooved to receive a rope; used for hoisting.
*Purlin.* One of several horizontal timbers that support rafters.
*Rafter.* A sloping timber giving support to a roof.
*Rake.* The slope of a roof; the sloping edge on a gable roof that may be covered with a barge board, or verge board.
*Ramp.* A sloping road or corridor. Also, the concave part at the top or cap of a railing, wall, or coping.

*Ridge*. The point on a double-sloping roof at which the rafters meet the ridge pole.

*Rise*. The vertical height of the top of a roof above the plate line, or the increase in height of a rafter per foot of run.

*Roofing*. Roofs collectively; materials for roofs; the act of covering a roof.

*Run*. Usually one-half the distance of the span of a roof.

*Scaffold*. A temporary elevated structure for the support of workers and materials during the construction of a building.

*Shake*. A rough, unshaved wood shingle.

*Sheathing*. The boards or other material used for covering the frame or roof structure.

*Shingle*. A unit of roofing; usually wood, composition, tile, or slate.

*Slope*. See "pitch."

*Soffit*. The underside of a beam, lintel, archway, cornice, or stairway.

*Span*. A space or distance between supports; in roof framing, the width of the frame between the outside edges of the building.

*Specifications*. Written information augmenting the plans of a building.

*Spigot*. A faucet for drawing asphalt from the kettle.

*Spire*. A tapering or pyramidal roof of a tower; a steeple.

*Spud (bar)*. A sharp, narrow spade for removing gravel and roofing; to dig or remove with a spud (bar), as to remove roof gravel.

*Stinger*. Part of the asphalt draw-off assembly that can be raised and lowered as needed. The stinger acts as a filter or screen.

*Stud*. An upright piece of lumber in the walls, 2 inches by 4 inches (5.1 centimetres by 10.2 centimetres), to which the gypsum wallboard is nailed.

*Talc*. A soft magnesium silicate used on roll roofing.

*Tar*. A by-product of coal; often referred to as coal tar or coal-tar pitch.

*Tile*. A thin piece of baked clay used for covering roofs; available in varied shapes.

*Toe board*. A protective board placed on a sloping roof to prevent workers from slipping or falling.

*Toenail*. A nail driven obliquely to hold the foot of a stud or brace; also, to draw boards into place.

*Truss*. A braced framework over long spans such as those found on large roofs or bridges; also, to brace or support by a truss.

*Valley*. The gutter or angle formed by the meeting of two roof slopes.

*Vault*. An arched structure; an arched ceiling or roof.

*Veranda*. An open portico or gallery along the side of a building; usually called a porch.

*Winch*. A hoist used for hauling or hoisting materials to the top of a roof.

# Roofing

## Entering the Roofing and Waterproofing Industry

## Tests

THE following section contains objective tests for each topic of the workbook. The value of the tests depends to a great extent on the care taken by instructors and school supervisors in keeping them confidential.

Supervisors and instructors should feel free to modify the application of the workbook material and the tests to satisfy local needs. Also, the instructors will probably supplement the information in the workbook with other material that they themselves have developed, and they will need to augment the tests with questions based on any supplementary material they may use.

Instructors and supervisors should be aware that the test pages are perforated to facilitate removal of the tests, either individually or as a complete set, at the discretion of the instructor or supervisor.



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TOPIC 1

# The Nature of the Roofing and Waterproofing Industry

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Roofing and waterproofing apprenticeship is a system of on-the-job training combined with classes of related: 1. _____

   1. Activity
   2. Instruction
   3. Drills
   4. Lectures

2. Entrance into the roofing and waterproofing apprenticeship program has always been based on employment opportunities, physical aptitudes, and: 2. _____

   1. Educational preparation
   2. Demonstration of trade skills
   3. Personality
   4. Need for employment

3. Individuals are selected for apprenticeship training without regard to their race, creed, color, sex, political opinions, or: 3. _____

   1. Age
   2. Abilities
   3. Height
   4. Aptitudes

4. In the ancient beginnings of apprenticeship, the teaching of a skilled craft was the direct responsibility of a(n): 4. _____

   1. Trade council
   2. Master
   3. Journey-level worker
   4. Employer

5. During the second historical phase of apprenticeship, responsibility for apprenticeship training belonged to the: 5. _____

   1. Masters
   2. Factory managers
   3. Unions
   4. Employers

6. Roofing and waterproofing apprentices must be prepared to: 6. _____

   1. Purchase needed books and materials.
   2. Attend instructional classes.
   3. Abide by the rules and regulations established by the joint apprenticeship and training committee.
   4. Do all of the above.

7. The fundamental purposes of roofing apprenticeship are to give qualified youths an opportunity to learn a skilled trade, to provide the industry with skilled workers, and to: 7. _____

   1. Test new construction methods.
   2. Upgrade the skills of journey-level workers.
   3. Motivate youths to study.
   4. Perpetuate the craft.

8. The term *construction industry* includes: 8. _____
   1. Construction firms but not unions
   2. Employers and journey-level workers but not apprentices
   3. Associated General Contractors of America
   4. Both labor and management

9. Through the 1990s employment in the roofing and waterproofing trade is expected to: 9. _____
   1. Increase.
   2. Decrease.
   3. Remain the same.
   4. Decrease and then increase.

10. The roofing and waterproofing apprenticeship program in California requires how many years for completion? 10. _____
   1. Two
   2. Three
   3. Four
   4. Five

TOPIC 2

# The Apprenticeship Program

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. The basic federal legislative act affecting apprenticeship is the: 1. _____
   1. Landrum-Griffin Act
   2. Fitzgerald Act
   3. Shelley-Maloney Act
   4. Fair Labor Standards Act

2. The basic California legislative act relating to apprenticeship is the: 2. _____
   1. Shelley-Maloney Act
   2. Fair Labor Standards Act
   3. Fitzgerald Act
   4. Davis-Bacon Act

3. Responsibility for keeping a record of apprentices' on-the-job training is assumed by: 3. _____
   1. The joint apprenticeship committee
   2. The employer
   3. The apprentice
   4. The business agent

4. The right of workers to bargain collectively is guaranteed by: 4. _____
   1. The Fair Labor Standards Act
   2. The California Plan for Equal Opportunity
   3. The National Labor Relations Act
   4. The Shelley-Maloney Act

5. Normally, apprentices are indentured to the: 5. _____
   1. Business agent
   2. Joint apprenticeship committee
   3. Employer
   4. Apprenticeship coordinator

6. The written authority under which each apprenticeship program is conducted is called the: 6. _____
   1. Apprentice agreement
   2. Indenture
   3. Constitution and bylaws
   4. Apprenticeship standards

7. Apprentices who work on federal public works projects receive certain fringe benefits that are mandated by: 7. _____
   1. Equal opportunity regulations
   2. The Davis-Bacon Act
   3. Union rules
   4. The Landrum-Griffin Act

8. How much are the members of the joint apprenticeship committee paid for their service on the committee? 8. _____

   1. $300 per month.
   2. $475 per month.
   3. $30 per scheduled meeting.
   4. Nothing—they are volunteers.

9. The practice of discrimination in matters of education, employment, housing, and voting is prohibited by what legislative act? 9. _____

   1. Civil Rights Act
   2. Walsh-Healy Act
   3. National Labor Relations Act
   4. Fitzgerald Act

10. Before an apprentice can be advanced to the next higher rate of pay, approval must be obtained from the: 10. _____

    1. Union business agent
    2. Joint apprenticeship committee
    3. Apprenticeship coordinator
    4. Division of Apprenticeship Standards

TOPIC 3

# Apprenticeship and the Public Schools

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Responsibility for the guidance and supervision of apprentices on the job is assumed by: 1._____
   1. The public schools
   2. Business agents
   3. Coordinators
   4. Industry

2. Responsibility for related instruction classes for apprentices is assumed by the: 2._____
   1. Director of Apprenticeship
   2. Joint apprenticeship committee
   3. Department of Education
   4. Public schools

3. Related instruction is given by a teacher who holds a California vocational teaching credential and who is a well-informed, highly skilled: 3._____
   1. Coordinator
   2. Business agent
   3. Journey-level worker
   4. Administrator

4. Each school district that provides related instruction obtains the advice and assistance of an educational: 4._____
   1. Coordinator
   2. Advisory committee
   3. Director
   4. Review board

5. The instructor of a related instruction class is an employee of the: 5._____
   1. Union
   2. Employers association
   3. Joint apprenticeship committee
   4. School district

6. Apprentices are required to attend related instruction classes: 6._____
   1. At their places of employment
   2. Unless excused by their employers
   3. If it is convenient for them to do so
   4. Regularly and promptly

7. The California Department of Education conducts training programs for: 7._____
   1. Union business agents
   2. Apprenticeship teachers and coordinators
   3. Apprentices
   4. Journey-level workers

8. Joint apprenticeship committees and educational advisory committees are made up of representatives of the: 8. _____

   1. Schools and employers
   2. Union and schools
   3. Employers and union
   4. Employers only

9. When an apprentice is working in an area where it is impossible for him or her to attend the required classes, the joint apprenticeship committee may provide for completion of the required assignments through: 9. _____

   1. The union business agent
   2. Equivalent on-the-job training
   3. Correspondence
   4. A traveling instructor

10. Which of the following is not generally used for related instruction classes? 10. _____

   1. Local high schools
   2. Community colleges
   3. Adult schools
   4. Local parochial schools

TOPIC 4

# Collective Bargaining, Wages, and Benefits

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Negotiation by representatives of both the union and the employer is called: 1. _____
   1. Direct negotiation
   2. Bilateral negotiation
   3. Collective bargaining
   4. Binding arbitration

2. Widespread acceptance of collective bargaining in the United States began with passage of the: 2. _____
   1. Articles of Confederation
   2. Wagner Act
   3. Fitzgerald Act
   4. Shelley-Maloney Act

3. Rules and guidelines for employers' and employees' participation in pension plans are provided by: 3. _____
   1. Social Security
   2. The Employee Retirement Income Security Act
   3. Workers' Compensation
   4. Medicare

4. A uniformly applied agreement between the subordinate bodies of the union and the employer organizations within a defined geographical area is called a(n): 4. _____
   1. Collective agreement
   2. Master agreement
   3. Limited agreement
   4. Area agreement

5. When a worker suffers an injury on the job, the responsibility for providing medical aid is assumed by: 5. _____
   1. The insurance company
   2. The worker
   3. The employer
   4. The Division of Industrial Accidents

6. Labor agreements are registered and filed with all appropriate state and federal agencies and are: 6. _____
   1. Informal agreements
   2. Not amendable
   3. Lawful contracts
   4. Statewide in scope

7. Labor agreements in the construction industry provide for pension plans and health and welfare plans that are paid for by the: 7. _____
   1. Union
   2. Employer
   3. Employee
   4. None of the above

8. The labor agreement in a contract area also provides for employer contributions to a trust fund for sponsoring: 8. _____

   1. Skills contests
   2. Industry-approved products
   3. The disability insurance program
   4. The apprenticeship program

9. The United Union of Roofers, Waterproofers, and Allied Workers provides its affiliated local unions and district councils with: 9. _____

   1. All necessary operating funds
   2. Much autonomy
   3. Officers and clerical staff
   4. Contract negotiators

10. In order to collect unemployment insurance in California, a worker must be: 10. _____

   1. Disabled
   2. A member of a union
   3. Physically able to work
   4. A journey-level worker

TOPIC 5

# Safety in the Industry

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. When rescuing a victim of electrical shock, the rescuer should first: 1.____
   1. Remove the victim from contact with energized wires or equipment.
   2. Find the power switch and turn off the power source.
   3. Begin resuscitation.
   4. Call an ambulance.

2. When coming to the aid of a burn victim, the person administering aid should first: 2.____
   1. Call a doctor.
   2. Report the incident to the supervisor.
   3. Immerse burns in cold water or apply ice directly to the burned area.
   4. Correct the hazardous condition that caused the accident to occur.

3. In the lifting of loads, the weight should be carried mostly by the muscles in the: 3.____
   1. Legs
   2. Back
   3. Arms
   4. Abdomen

4. Which of the following symptoms indicates heat exhaustion? 4.____
   1. Hot and dry skin
   2. Muscular cramps
   3. Damp and cold skin
   4. Dilated pupils

5. Carrying hotstuff up ladders is: 5.____
   1. Prohibited by provisions of the *Construction Safety Orders*
   2. Permitted as long as the ladder meets industry standards
   3. Permitted only for journey-level workers
   4. Accepted as common practice in the industry

6. If a worker is directed to perform work that would violate safety orders or create a real and apparent hazard, he or she should: 6.____
   1. Perform the work.
   2. Agree to perform the work only for overtime pay.
   3. Refuse to perform the work.
   4. Perform the work, but report his or her supervisor to the proper authority.

7. Goggles must be worn by: 7.____
   1. Kettle operators while operating kettles
   2. All apprentices, regardless of the work they perform
   3. Forklift drivers
   4. Safety inspectors

8. When someone has fainted, the person administering aid should: 8. _____
   1. Use mouth-to-mouth resuscitation.
   2. Keep the victim's head lower than the heart.
   3. Cover the victim with a blanket.
   4. Administer cardiac compression.

9. Ladders placed against the side of a building should extend how many feet above the roof eave? 9. _____
   1. 1
   2. 3
   3. 4
   4. 5

10. When a worker is injured, he or she should: 10. _____
    1. Report the injury to the supervisor if it is necessary to call a doctor.
    2. Report the injury unless it is merely a small cut or abrasion.
    3. Report the injury in all cases.
    4. Report the injury if it is likely to recur.

TOPIC 6

# Types, Styles, and Structural Designs of Roofs

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Which of the following types of roofs is not commonly used on residential structures? 1.____

   1. Gable
   2. Sawtooth
   3. Hip
   4. Mansard

2. The strongest part of a gable roof is the: 2.____

   1. Eaves
   2. Field
   3. Ridge
   4. Parapet wall

3. The total run of a roof is always: 3.____

   1. The same as the total span
   2. Twice the total span
   3. One-half of the total rise
   4. One-half of the total span

4. Loads placed on roofs should generally be placed only over the: 4.____

   1. Ridge
   2. Eaves
   3. Beams and trusses
   4. Rake

5. The strength of eaves can be increased by nailing which of the following across the ends of the rafters? 5.____

   1. Cornice
   2. Frieze
   3. Fascia
   4. Top plate

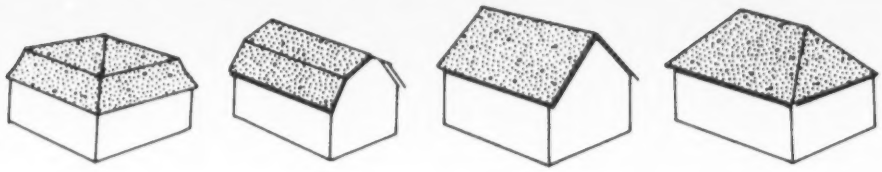
6. A hip roof slopes in how many directions? 6.____

   1. One
   2. Two
   3. Three
   4. Four

7. The vertical distance from the top of the plate line to the top of the ridge of a gable roof is called the: 7.____

   1. Total rise
   2. Total span
   3. Total run
   4. Rake

8. Which of these illustrations shows a hip roof? 8. _____



A B C D

1. A
2. B
3. C
4. D

9. The underside of which type of roof may also serve as the ceiling of a house? 9. _____

1. Hip
2. Flat
3. Gambrel
4. Barrel

10. The gutter or angle formed by the meeting of two roof slopes is called a: 10. _____

1. Valley
2. Trough
3. Rake
4. Field

TOPIC 7

# Hand Tools and Power Tools

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Which of the following is not part of the roofer's basic tool kit? 1.____
   1. Pry bar
   2. Chalk line
   3. Tin snips
   4. Nail set

2. When operating a tile saw, the worker should: 2.____
   1. Wear a respirator and goggles or a face shield.
   2. Work indoors if possible.
   3. Ensure that other workers are no closer than 15 feet (4.6 metres).
   4. Do all of the above.

3. Improper use of tools: 3.____
   1. Is considered a misdemeanor
   2. Can result in serious injury to the user
   3. Is expressly forbidden in the *Construction Safety Orders*
   4. Should be overlooked if the resulting work is acceptable

4. Sharp tools should be carried only in: 4.____
   1. Shirt pockets
   2. Rear pants pockets
   3. The hand
   4. None of the above

5. In the roofing and waterproofing industry, portable electric saws are most often used for cutting: 5.____
   1. Rafters
   2. Reglets
   3. Wood for barricades
   4. Rakes

6. After the apprentice has purchased the basic tools needed in the trade, he or she should purchase additional tools: 6.____
   1. As soon as possible
   2. As the need for them arises
   3. As told to by the joint apprenticeship committee
   4. As they go on sale

7. Which of the following types of wrenches is part of the roofer's basic tool kit: 7.____
   1. Allen
   2. Open-end
   3. Box
   4. Crescent

8. Tools that are well cared for are an indication of the worker's: 8._____
   1. Upbringing
   2. Pride in the job
   3. Ability to buy expensive tools
   4. Lack of work

9. The majority of tools used in the industry are supplied by: 9._____
   1. The union
   2. The employer
   3. The worker
   4. None of the above

10. Which of the following items is (are) required for the operator of a tile saw? 10._____
    1. Gloves
    2. Eye protection device
    3. Dust respirator
    4. All of the above

TOPIC 8

# Equipment

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Before hotstuff is poured into a bucket of any type, the bucket should be examined to ensure that: 1. _____
   1. It is large enough.
   2. The handle is of one-piece construction.
   3. It contains no moisture.
   4. All of the above.

2. Most felt layers are suitable for working only on: 2. _____
   1. Barrel roofs
   2. Level roofs or nearly level roofs
   3. Hip roofs
   4. All roofs commonly used on residential structures

3. Operating a felt layer can be dangerous because the operator must: 3. _____
   1. Walk backward.
   2. Walk slowly.
   3. Retrace his or her steps.
   4. Complete his or her work before safety barricades are set in place.

4. Spans between roof brackets should not exceed how many feet? 4. _____
   1. 9
   2. 10
   3. 12
   4. 13

5. Spudding machines are used to: 5. _____
   1. Clean up after the gravel-spreading operation has been completed.
   2. Loosen old roofing or gravel.
   3. Apply spuds over the layer of gravel.
   4. Remove felt layers that have been applied improperly.

6. Roofing brackets, or jacks, must be used on roofs that have a pitch of at least: 6. _____
   1. 1/8 (3/12)
   2. 1/4 (6/12)
   3. 1/3 (8/12)
   4. 1/2 (12/12)

7. Which type of fire extinguisher is most effective for fighting asphalt fires? 7. _____
   1. Pump tank
   2. Spray type
   3. Dry powder type
   4. Foam type

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8. Spray equipment is most often used in the roofing industry to: 8._____
   1. Apply asphalt.
   2. Apply protective coatings and primers.
   3. Clean other equipment.
   4. Extinguish fires.

9. The roofer's bucket is made of what gage steel? 9._____
   1. 18
   2. 22
   3. 24
   4. 26

10. An instrument used to apply hot asphalt in the waterproofing of walls is the: 10._____
   1. Roller mop
   2. Ladle
   3. Spudding bar
   4. Pouring can

TOPIC 9

# Introduction to Kettles

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. The type of kettle used most often in the roofing and waterproofing industry is the: 1.____
   1. Bottom-fired kettle
   2. Liquid petroleum kettle
   3. Kerosene-heated kettle
   4. Alcohol-fired kettle

2. Propane burners differ from kerosene burners in that propane burners: 2.____
   1. Have no coils.
   2. Are difficult to transport.
   3. Are corrosion proof.
   4. Require no shell.

3. Which of the following is the major advantage of automatic kettles? 3.____
   1. Their initial purchase price is low.
   2. Mechanical repairs are simple to make.
   3. Any type of bitumen can be used to fire them.
   4. Overheating can be controlled.

4. In a kerosene-heated kettle, kerosene is mixed with: 4.____
   1. Propane
   2. Air
   3. Butane
   4. Water

5. Expansion of LP gas is caused by: 5.____
   1. Compression
   2. Oxygen
   3. Dirt in the kettle shell
   4. Heat

6. LP gas containers should be: 6.____
   1. Filled completely
   2. Filled only by the job supervisor
   3. Filled less than full
   4. Emptied and cleaned daily

7. Most kettles in use today are constructed so that heat is directed through: 7.____
   1. Tubes
   2. The exterior wall of the shell
   3. The draw-off cock
   4. Stacks

8. Starting a beginning apprentice on the kettle is: 8.____
   1. A good practice
   2. A bad practice
   3. Recommended by the joint apprenticeship committee
   4. Required by the *Construction Safety Orders*

9. Which of the following is classified as LP gas? 9. _____

   1. Bitumen
   2. Butane
   3. Kerosene
   4. Liquid oxygen

10. The safety kettle cover is designed primarily to: 10. _____

   1. Prevent vandals from throwing objects into the kettle.
   2. Serve as a seat for the kettle operator.
   3. Hold heat inside the kettle.
   4. Prevent hot bitumen from splashing out of the kettle.

# TOPIC 10 Lighting and Loading of Kettles

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. The air pressure in the kerosene tank of a kerosene burner should be approximately how many pounds? 1.____

   1. 20
   2. 25
   3. 30
   4. 40

2. Which of the following is a bad practice with a kerosene-heated kettle? 2.____

   1. Operating the burner on a low flame for a long period of time
   2. Leaving some air space in the kerosene tank when filling it
   3. Using a kerosene-soaked cloth as a wick
   4. Placing the burner pan on the ground when running raw kerosene into it

3. The first step in lighting an automatic kettle is to: 3.____

   1. Light the pilot light.
   2. Set the thermostat to the desired temperature.
   3. Pump air into the tank.
   4. Open the safety valve.

4. In operating the kettle, the kettle operator should ensure that: 4.____

   1. The tubes are completely surrounded by bitumen before he or she lights the burner.
   2. Only large pieces of bitumen are placed in the kettle.
   3. The burner is set high enough to melt the bitumen rapidly.
   4. The pilot light has been extinguished.

5. Once the bitumen in the kettle is melted, the kettle operator should add pieces of bitumen until the kettle is at least: 5.____

   1. One-quarter full
   2. One-half full
   3. Three-fourths full
   4. Full

6. Persons other than the kettle operator should remain at least how far away from a hot kettle? 6.____

   1. 20 feet
   2. 30 feet
   3. 40 feet
   4. 50 feet

7. Most automatic kettles operate only on: 7.____

   1. Kerosene
   2. Butane or propane
   3. Coal-tar pitch
   4. All of the above

8. If the pilot light of some automatic kettles goes out: 8. _____
   1. More fuel should be added.
   2. Larger chunks of bitumen should be added to the kettle.
   3. The flow of gas to the burner is stopped automatically.
   4. The desired temperature has been reached.

9. Which of the following practices helps to increase the overall efficiency of a roofing operation? 9. _____
   1. Slightly overheating the kettle to speed up the rate at which the bitumen melts
   2. Heating a cold kettle full blast
   3. Having a supply of bitumen chopped and ready for loading at all times during kettle operation
   4. All of the above

10. If raw kerosene should escape from the burner during the lighting procedure, the kettle operator should: 10. _____
    1. Begin the entire lighting process again.
    2. Disregard the spill because kerosene is relatively inexpensive.
    3. Reduce the air pressure.
    4. Move the burner to another area.

TOPIC 11

# Kettle Heating

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Heating asphalt higher than the manufacturer's recommendations will: 1.____
   1. Have no negative result whatsoever.
   2. Burn off certain oils, causing the asphalt to carbonize and become brittle and thereby shorten the life of the roof.
   3. Increase the amount of napthalene present in the asphalt.
   4. Enable the kettle operator to keep up with the demand for hotsuff on a large job.

2. A pitch kettle can be expected to flash when escaping vapors turn what color? 2.____
   1. Orange
   2. Yellow-green
   3. Black
   4. Gray

3. If a flash fire occurs in a kettle, the kettle operator should immediately: 3.____
   1. Call the fire department.
   2. Notify the job supervisor.
   3. Close the kettle lid.
   4. Draw off the burning mixture.

4. Carbon formation around heating tubes can cause or require: 4.____
   1. Increased danger of fire
   2. Heat loss
   3. Increased heating time
   4. All of the above

5. When hotstuff is required early in the workday, the kettle operator should: 5.____
   1. Fire the kettle as soon as the crew arrives on the job site.
   2. Explain to the crew that the heating operation cannot be rushed.
   3. Fire the kettle at least 1 hour before the crew is scheduled to arrive.
   4. Ask another worker to fire the kettle before he or she arrives.

6. To protect his or her skin during pitch-kettle operation, the kettle operator should: 6.____
   1. Wear protective lotion on exposed skin areas.
   2. Stand at least 30 feet away from the kettle.
   3. Stand downwind from the kettle.
   4. Do all of the above.

7. After a kettle flash fire has been extinguished, the kettle lid should be opened carefully because: 7.____
   1. The hinges may have melted to a defective state.
   2. Escaping vapors may flash again.
   3. Small chunks of bitumen may explode.
   4. The pilot light may still be burning.

8. Burning tar on the outside of a kettle is: 8._____
   1 Easy to extinguish
   2. Somewhat difficult to extinguish
   3. Practically impossible to extinguish
   4. All of the above

9. Kettles should always be operated in accordance with: 9._____
   1. The specifications set forth in the *Construction Safety Orders*
   2. The job superintendent's instructions
   3. The manufacturer's instructions
   4. All of the above

10. Which of the following may require changes in kettle-operating procedures? 10._____
   1. A change in the material being heated
   2. New air pollution standards
   3. Revised safety regulations
   4. All of the above

# TOPIC 12 Kettle Cleaning and Maintenance

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. The exterior of the kettle should be cleaned at least: 1.____
   1. Daily
   2. Weekly
   3. Twice a day
   4. Twice a week

2. The accuracy of the kettle thermometer and thermostat should be checked how often? 2.____
   1. Every day
   2. Every 2 weeks
   3. Every 30 days
   4. Every 24 hours of operation

3. When replacing the draw-off cock after cleaning, the kettle operator should: 3.____
   1. Be careful not to strip the threads.
   2. Use a wrench to ensure that the draw-off cock is properly tightened.
   3. Check the engine oil level at the same time.
   4. Be sure the safety valve is in the open position.

4. The kettle engine's oil level should be checked how often? 4.____
   1. Every 2,000 miles
   2. Every 36 hours
   3. Every other day
   4. Daily

5. The kettle should be cleaned only when: 5.____
   1. It is being used on a small job.
   2. It is cold.
   3. It is hot.
   4. Another kettle is on the job site and ready for use.

6. Which of the following tools should be used to clean built-up carbon from round heating tubes? 6.____
   1. Putty knife
   2. Screwdriver
   3. Hatchet
   4. Hammer

7. Pounding burners on the ground to loosen carbon deposits is a bad practice because: 7.____
   1. Burners crack easily.
   2. The cleaning needle can easily be knocked out of line.
   3. Workers could stumble in the resulting ground depression.
   4. Leaks could result.

8. Which of the following can be caused by improper maintenance of the kettle? 8. _____
   1. Job completion delays
   2. Injuries to workers
   3. Additional overhead expenses
   4. All of the above

9. Tar can be removed from the kettle lid, sides, fenders, and so forth with a: 9. _____
   1. Hammer
   2. Tin snips
   3. Putty knife
   4. Hatchet

10. Which of the following can be caused by carbon buildup? 10. _____
    1. A warped kettle lid
    2. Loss of asphalt flow to the roof
    3. Failure of the kettle to heat
    4. All of the above

TOPIC 13

# Roof Pumps

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Approximately what percent of roofing accidents involve handling hotstuff in buckets? 1.____

   1. 50
   2. 60
   3. 70
   4. 72

2. Before pumping begins in the heavy-duty, single-line pumping system, the kettle operator should: 2.____

   1. Grease the zerk fitting on the pump.
   2. Check the filler pipe to the receptacle for moisture.
   3. Close the quick-acting valve.
   4. Start the engine that drives the pump.

3. The zerk on a pump should be lubricated: 3.____

   1. At least daily
   2. At least weekly
   3. Every 30 days
   4. After every firing

4. Highboys used to receive hotstuff on the roof are usually of what capacity? 4.____

   1. 20 gallons
   2. 30 gallons
   3. 40 gallons
   4. 50 gallons

5. In a submerged pumping system, the pump is: 5.____

   1. Immersed in the bitumen
   2. Mounted on the rear platform of the kettle
   3. Attached to the fender of the kettle
   4. None of the above

6. The major advantage of a submerged pumping system is that: 6.____

   1. Little maintenance is required.
   2. Little vibration occurs during operation.
   3. The pump is hot whenever the bitumen is hot, and the operation begins as soon as the engine is started.
   4. Bitumen can be lifted as high as 200 feet.

7. Thin-wall metal tubing for use in elevating hotstuff to the roof is available in lengths of: 7.____

   1. 3 to 20 feet
   2. 5 to 15 feet
   3. 5 to 20 feet
   4. 10 to 20 feet

8. On heavy-duty, single-line pumping systems, which of the following is (are) attached to the kettle? 8._____

   1. The engine
   2. The pump
   3. The supply lines
   4. All of the above

9. Thin-wall tubing is: 9._____

   1. Difficult to obtain
   2. Easy to erect
   3. Heavy
   4. All of the above

10. A major advantage of heavy-duty, single-line pumping systems is that: 10._____

   1. Hotstuff remains at a temperature that allows for easy mopping.
   2. The receptacle into which the hotstuff is drawn off need not be checked first for moisture.
   3. Only about 30 seconds is required to fill a 30-gallon highboy.
   4. The kettle operator is less likely to suffer burns.

TOPIC 14

# Tankers

Decide which of the four answers is correct, or most nearly correct; then write the corresponding number in the blank at the right.

1. Bulk-asphalt tankers have been used in the roofing industry for more than: 1. _____
   1. 10 years
   2. 15 years
   3. 25 years
   4. 35 years

2. Most tankers and asphalt storage tanks have: 2. _____
   1. Built-in safety systems
   2. Steam generators
   3. Their own kettles
   4. All of the above

3. The siphon pipe for determining the level of asphalt in a tank is usually kept how many inches above the heating tubes? 3. _____
   1. 6
   2. 10
   3. 12
   4. 14

4. With a manually operated burner control system, the burner should not be fired unless the asphalt level is at least how many inches above the heating tubes? 4. _____
   1. 6
   2. 8
   3. 10
   4. 12

5. Fully automatic burner control systems are found on: 5. _____
   1. Tankers
   2. Ground-mounted storage tanks
   3. Tankers and ground-mounted storage tanks
   4. None of the above

6. The first tankers used for asphalt were: 6. _____
   1. Built in 1937
   2. Converted milk or oil carriers
   3. Converted boxcars
   4. Converted ice cream trucks

7. The ideal temperature for storing liquid asphalt is: 7. _____
   1. 50 degrees
   2. 375 degrees
   3. 400 degrees
   4. 425 degrees

8. With a semiautomatic burner control system, once the burner shuts down: 8. _____
   1. It can only be restarted manually.
   2. It cannot be restarted until the temperature of the asphalt reaches 400 degrees.
   3. The tubes must be thoroughly cleaned.
   4. The siphon pipe cannot be raised.

9. Manually operated burner control systems require that the operator: 9. _____
   1. Be constantly aware of the level of asphalt in the tank.
   2. Frequently check the thermometer.
   3. Make sure the asphalt level is at least 6 inches above the heating tubes.
   4. Do all of the above.

10. Tankers: 10. _____
   1. Can be used to perform the same functions as kettles
   2. Should not be used as kettles
   3. Must bear the approval seal of the American Association of Asphalt Tank Manufacturers (AAATM)
   4. Are available in two sizes only



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